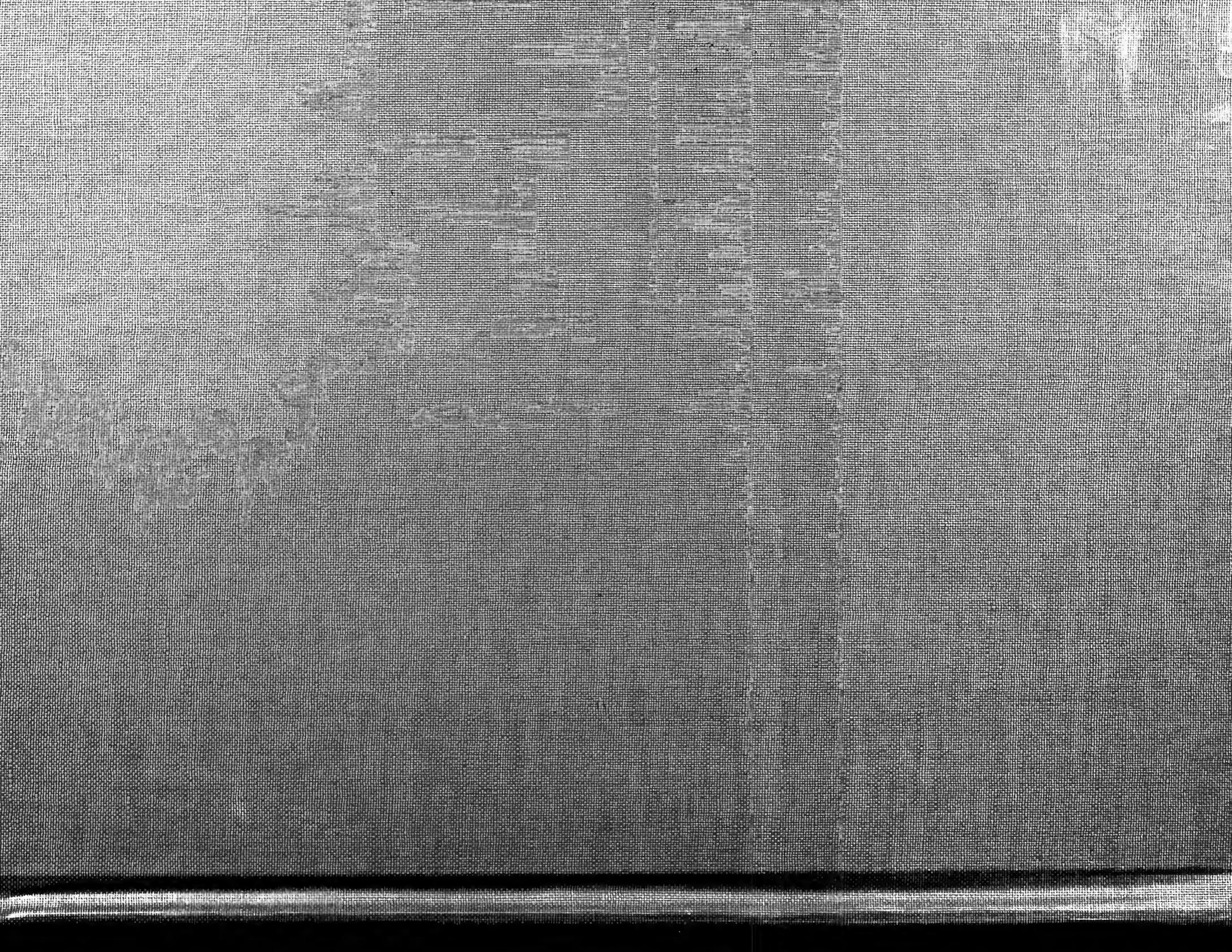


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THE

JOHN MURRAY EXPEDITION

1933-34

SCIENTIFIC REPORTS

VOLUME XI 1966-1967

ZOOLOGY

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A REVIEW OF THE CEPHALOPOD FAMILY SEPIIDAE

BY

WILLIAM ADAM (BRUXELLES)

and

WILLIAM J. REES (LONDON)



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LONDON: 1966

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I. INTRODUCTION

This review of the cephalopod family Sepiidae was begun by the authors in 1947 and for various reasons was laid aside until 1961 when it was decided to complete the work.

During 1947 the senior author visited the British Museum (Natural History) to study its rich type collections[1] and it was then decided to undertake a joint report on the interesting collection of Sepiidae brought back by the John Murray Expedition to the Indian Ocean in 1933-1934.

We had the opportunity to compare these and other species with the types described by John Edward Gray in 1849. Most of Gray's types were still in fairly good condition but had never been described in detail or figured and for this reason had always remained doubtful species or had been subsequently misidentified. It was therefore decided to re-describe Gray's Sepiidae and also some South African forms which had been confused by several authors.

The completion of this study was delayed but it was arranged in 1961 for the senior author to visit London so that the task could be resumed and at the same time the scope of the report was enlarged to include all the Sepiidae in the collections of the British Museum, with the exception of West African and European species; the Sepiidae of these two areas being already sufficiently known.

Even though these collections are rich in species, most of the Japanese and Australian forms are lacking so that it is not yet possible to present a complete monograph of the whole family. The Japanese species have been well described in Sasaki's monograph (1929) but the Australian forms, most of which were described by Iredale (1926, 1940, 1954, 1955) only from cuttle-bones are very imperfectly known.

Nevertheless it seems advisable to give a critical revision of all recent Sepiidae hitherto described.

The authors wish to thank Dr F. C. Fraser and Mr N. Tebble for facilitating much of our work and Mr H. O. Ricketts for his kind and valuable assistance. For material, information and photographs of species, thanks are due to: Dr K. H. Barnard (South African Museum, Cape Town), Mr B. C. Cotton (South Australian Museum, Adelaide), Professor J. H. Day (University of Cape Town), Dr W. S. S. van der Feen-van Benthem Jutting (Zoological Museum, Amsterdam), Professor E. Fischer-Piette (National Museum of Natural History, Paris), Dr J. Knudsen (Zoological Museum, Copenhagen), Dr D. F. McMichael (Australian Museum, Sydney), Miss V. Orr (Academy of Natural Sciences, Philadelphia), Dr H. A. Rehder (Smithsonian Institution, Washington), Dr H. Steinitz (Hebrew University, Jerusalem) and Dr G. L. Voss (University of Miami). Most of the photographs illustrating this review have been skilfully produced by the Photographic Section of the Museum, the majority being taken by Mr J. V. Brown and Mr P. J. Green.

In addition the senior author wishes to acknowledge a grant from the Trustees of the British Museum to enable him to visit London in 1961 to re-examine all the material.

The conclusions reached on the status of the different species have been jointly agreed by both authors, but the junior author would like to express his indebtedness to Dr Adam for drafting this report. The preparation of this final draft for the press and the assembly of the plates has been done in London by the junior author.

Both authors are deeply conscious of the inadequacy of our knowledge of the living animals of the genus *Sepia*. The best known is of course *Sepia officinalis*, which, besides being the type species of

[1] This visit was supported by a grant from the Belgian "Fonds National de la Recherche Scientifique" for which the senior author expresses his sincere gratitude.

the genus, is also a teaching type in European Universities and has been used for many experimental and behavioural studies. Of the remaining species, only in less than half a dozen do we know anything about general biology, physiology and reproduction. For these reasons we are, as we have said, very conscious of great gaps in our knowledge of the Sepiidae. Nevertheless we believe that this survey, including as it does a re-assessment of John Edward Gray's early material and of the Challenger Sepiidae, together with the John Murray Expedition's collections as well as other specimens in the British Museum, will go a long way towards establishing how many species there are–and not least it does not attempt to hide the serious deficiencies in our knowledge of the Australian Sepiidae.

II. ABBREVIATIONS

A.L. I	length of dorsal arms (measured from the first proximal sucker to the distal arm tip).	L.M.	length of mantle.
		Loc.	locality.
		m	metre.
		mm	millimetre.
A.L. II	length of dorso-lateral arms.	M.L.d.	dorsal length of mantle.
A.L. III	length of ventro-lateral arms.	M.L.v.	ventral length of mantle.
A.L. IV	length of ventral arms.	M.N.H.N.P.	Muséum National d'Histoire Naturelle (Paris).
B.M.	British Museum.		
f.	fathoms.	M.W.	width of mantle.
F.L.	length of fins.	s.	sand.
fms.	fathoms.	S.a.	diameter of arm suckers.
F.W.	width of fins.	sh.	shell.
ft.	feet.	sp.	specimen.
gn.m.	green mud.	S.t.	diameter of tentacular suckers.
H.L.	length of head.	Str.z.	length of striated zone.
H.W.	width of head.	T.cl	length of tentacular club.
I.R.S.N.	Institut royal des Sciences naturelles (Brussels).	Th.	thickness.
		T.L.	total length of tentacle.
juv.	juvenile.	W.	width.
L.	length.	W.P.	width of protuberance.
L.loc.	last loculus.		

III. DESCRIPTION OF SPECIES

1. ***Sepia thurstoni*** sp. nov.

(Pl. 1, figs. 1–4; pl. 41, fig. 235)

Sepia rouxii Hoyle, 1904*a*, p. 198 (*non* Férussac & d'Orbigny).
Sepia rostrata (pars) Winckworth, 1936, p. 16 (*non* Férussac & d'Orbigny).
Sepia sp. Adam, 1939, p. 80, pl. III, figs. 1 & 2.

TYPE LOCALITY: Ramesvaram Island, Madras.
GEOGRAPHICAL DISTRIBUTION: Madras; off Negombo and Hambantota, Ceylon.
MATERIAL:

a. Ramesvaram Island, Madras (Coll. Thurston); B.M. 1894.9.6. 2–4: 1 ♂ (holotype).

b. off Negombo, Ceylon, 12–20 fms., 31. i.1902; bottom, coarse yellow sand; B.M. 1947.5.5.36; 1 ♀ (paratype; det. Hoyle, 1904 as *Sepia rouxii*).

c. Hambantota, Ceylon, 16.xii.1926 (Coll. Winckworth, Mus. roy. Hist. nat. de Belgique); 2 shells (paratypes).

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a	♂	84	95	52	25	43	–	14	54
b	♀	74	91	50	26	43	–	15	38

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	♂	84	48	49	64	138	22·5	1·7	1·1
b	♀	74	38	37	46	100	20	1·6	1·0

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
a	♂	80	39	10·6	69	3·8	pl. 1, figs. 1 & 2
b	♀	73	37	7·3	67	3·4	pl. 1, figs. 3 & 4
c	–	105·5	39	8·1	77	4·3	
	–	63	39·5	7·1	59	5·5	

DESCRIPTION: The male specimen, labelled "*Sepia indica*", is in a good state of preservation. It has a short, rather broad body. The dorsal surface of head, arms and mantle is of a fairly uniform, faintly transversely-striated, blue-black colour (in spirit) with densely crowded chromatophores. The latter are much less dense on the fins and on the ventral side so that the ground colour of the skin is not obscured.

The mantle is widest in the middle of the body and tapers bluntly posteriorly. Its ventral margin is only slightly emarginate, but dorsally it is emarginate behind the eyes, and projects forward in the median line to midway between the eyes. The fins are well developed and fleshy; they reach to within 3 mm of the mantle margin and extend posteriorly beyond the mantle tip.

The head is as wide as the mantle opening. The eyes are large and the bluntly-conical funnel reaches nearly to the angle between the ventral arms.

All the arms are laterally compressed; the dorsal ones are rounded at their bases and faintly keeled near their tips. The dorso-lateral arms are also faintly keeled, the keel descending to the ventral margin of the outer side. The ventro-lateral arms are still more strongly keeled and the ventral ones possess strong swimming-membranes on the outer sides of their ventral surfaces. All the arms possess well-developed protective membranes.

The web is rudimentary between the dorsal and dorso-lateral arms; it reaches the third and fourth rows of suckers between the lateral arms and the fifth row of suckers between the ventro-lateral and ventral arms; it is absent between the ventral arms.

The left ventral arm is hectocotylized: the first five rows of proximal suckers are of normal size, followed by seven rows of reduced suckers in the basal half of the arm. The inner and outer rows of suckers of the dorsal side are abruptly reduced to vestiges of widely separated suckers, each with

a diameter of 0·6 mm, but the ventral inner and outer rows are less reduced. Of these ventral suckers the first three are almost of normal size, while the remainder are slightly smaller. Beyond the middle of the arm the suckers become normally quadriserial as on the other arms.

The tentacular stem is triangular in cross-section, with a blunt keel. The club has a well-developed swimming-membrane in the middle of the dorsal side; it is not continuous with the outer keel of the stem and is slightly longer than the club (pl. 41, fig. 235). The protective membranes are rather narrow; they remain separated at the base of the club and continue down the stem as faint ridges. The subequal suckers are arranged in eight longitudinal series.

The female paratype, which had been identified by Hoyle (1904, p. 198) as *Sepia rouxii*, is smaller and has a paler appearance. The ventral part of its buccal membrane is widely expanded and shows two spermathecae very distinctly.

The shell of the male is oval, flattish, rounded at both ends, with a rounded spine directed upwards. (pl. 1, figs. 1 & 2). The convex dorsal surface has a low median rib and two very faint lateral ribs. The surface is finely granular corresponding to the growth lines. The chitinous marginal zones are narrow.

The ventral surface has a broad median depression extending to the posterior border of the last loculus, the latter being slightly convex. The striated area is separated from the outer cone by two nearly smooth, slightly-striated, lateral zones.

The striae of the striated area are slightly convex in the posterior part, becoming more and more pronounced towards the last loculus.

The inner cone is hollow, its posterior part forming a wide, thick, slightly convex border. Its broad lateral limbs are completely fused with the outer cone. The latter is well developed in the posterior half of the shell, surrounding the inner cone.

The shell of the female is slightly narrower and flatter and the ventral median depression is shallower (pl. 1, figs. 3 & 4). In both sexes the posterior part of the dorsal surface is smooth and shiny, but does not seem covered by a glaze-like substance.

Remarks and relationships: Our new species somewhat resembles *Sepia brevimana* but in this species the tentacular club is different. The shell of the latter species is acuminate, especially at the anterior end; the posterior portion of the inner cone is much less developed and the median ventral groove much shallower in the male. The dorsal surface of the shell of *S. brevimana*, especially of the male, is distinctly different in having flattened areas between the ribs which are covered with tubercles.

The tentacular club of *S. thurstoni* is similar to that of *S. lycidas*, but the shell of the latter differs, in the absence of smooth zones between the striated area and the outer cone, in that the limbs of the inner cone are narrow and raised without being fused to the same extent with the outer cone and in the glaze-like covering of the posterior part of the dorsal surface.

The shell of *S. thurstoni* shows a great resemblance to that of *S. zanzibarica*, but the former has a flatter ventral surface and the limbs of the inner cone much broader, whereas the spine has no lateral expansions at its base.

The tentacular club of *S. zanzibarica* differs in its unequal suckers, the median ones being distinctly larger than the marginal ones.

Adam (1939*c*, p. 80) pointed out that his *Sepia* sp. from Hambantota, which we refer to *S. thurstoni*, strongly resembled some poorly preserved shells from Madagascar. In fact these later shells belong to *S. zanzibarica*.

Finally, the shell of *S. thurstoni* shows some resemblance to that of *S. aculeata*, especially as regards the posterior portion of the inner cone, but its fused limbs are much wider and instead of being convex as in *S. aculeata* the striated area shows a deep grove.

2. *Sepia brevimana* Steenstrup, 1875
(Pl. 2, figs. 5–8)

Sepia brevimana Steenstrup, 1875, pp. 475, 497; 1881, pl. I, figs. 24–26; 1962, pp. 93, 106, pl. I, figs. 24–26; Tryon, 1879, p. 197; Hoyle, 1886, pp. 22, 130, 133, 139, 218; Adam, 1939*c*, pp. 72, 81, 88; Adam, 1965, p. 172, pl. 30, figs. 1–3.
Sepia rostrata (pars) Férussac & d'Orbigny, 1848, p. 284, pl. 26 (*non* 1835, pl. 8); Winckworth, 1936, p. 16.
Acanthosepion rostratum, Rochebrune, 1884, p. 102, pl. 6, fig. 1; Adam, 1944, p. 230.
Sepia winckworthi Adam, 1939*a*, p. 1, fig. 1, pl. I; 1939*c*, p. 79, pl. III, figs. 7–9.
Acanthosepion spinigerum (pars) Rochebrune, 1884, p. 103; Adam, 1944, p. 230.

TYPE LOCALITIES: Indian Ocean (*S. brevimana*); Singapore (*S. winckworthi*).
GEOGRAPHICAL DISTRIBUTION: Indian Ocean; Java Sea.
MATERIAL:

a. Sarawak (Santubong and Buntal) (Coll. Bartlett); B.M. 1894.7.14.10; 1 shell.
b. Andaman Islands; B.M. 1907.8.30.189–190; 2 shells.
c. Madras, 23.x.1927; B.M. 1952.11.24.56–58; 3 shells.
d. Hambantota, 16.xii.1926: B.M. 1952.11.24.62–64; 3 shells.
e. Madras, 1.iv.1930; B.M. 1952.11.24.65–66; 2 shells.
f. Singapore, May, 1933; B.M. 1952.11.24.67; 1 shell.
g. Mannar, 30.xii.1924; B.M. 1952.11.24.68–71; 4 shells.
h. Puri, 22.iv.1929; 15.iii.1929; 30.v.1929; B.M. 1952.11.24.72–74; 3 shells.
i. Madras, 18.ix.1930; B.M. 1952.11.24.75-76; 2 shells.
j. Puri, 22.iv.1929; B.M. 1952.11.24.77; 1 shell.
k. Juhu, 4.xi.1928; B.M. 1952.11.24.78; 1 shell.
l. Madras, 6.vi.1924, B.M. 1952.11.24.94–95; 2 shells (anterior portion damaged).
m. Port Blair, ii.1937; B.M. 1952.11.24.130; 1 shell.

With the exception of the first two localities (*a* and *b*), all the remaining material is from the Winckworth collection and was identified by him as *Sepia rostrata*.

MEASUREMENTS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
c	?♂	78	41	7·7	71	4·5	
c	?♂	78	37	9·0	67	5·1	
e	?♂	76	36	7·9	71	5·3	
h	?♂	76	41	7·9	74	5·9	
m	?♂	75	41	8·0	72	6·0	
c	?♂	72	39	9·0	63	6·3	pl. 2, figs. 5 & 6
j	?♂	50	43	9·6	56	8·0	
k	?♂	42	43	7·4	64	8·3	
h	?♂	33	50	9·7	51	8·8	
d	?♀	111	35	7·7	78	3·6	
d	?♀	77	41	7·1	74	3·2	
i	?♀	69	38	8·3	70	8·7	
i	?♀	67	40	8·5	69	7·5	
f	?♀	65	40	7·7	71	6·2	pl. 2, figs. 7 & 8
e	?♀	64	39	8·3	66	8·6	
a	?♀	60	43	8·3	72	7·5	
d	?♀	52	41	8·6	63	2·9	
g	?♀	52	39	8·7	62	4·8	
g	?♀	44	41	9·1	64	5·7	
h	?♀	40	42	7·5	58	10·0	

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
g	? ♀	36	43	8·3	61	5·6	
g	? ♀	34	44	8·5	65	5·9	
b	?	53	38	7·7	–	6·6	
b	?	32	44	7·8	59	7·8	

DESCRIPTION: The collections of the British Museum do not contain a single animal of this species. The animal was described as *S. winckworthi* by Adam (1939, p. 4), who received it from Winckworth after the shell had been removed.[1] This specimen is a female from Singapore (May, 1933). Among the above-mentioned shells from the Winckworth collection is a single shell from the same locality (*f*) which probably belongs to this female specimen; it is a little longer than the animal (57 mm) but this may be due to contraction of the latter in spirit.

The mantle is broad; its ventral margin is slightly concave and its dorsal margin is acuminate and projects strongly. The posterior end is also very acuminate due to the long spine of the shell.

The fins begin a few millimetres behind the mantle-margin beyond which they do not project anteriorly.

The arms are subequal and do not attain half the mantle-length. Their swimming-membranes and protective membranes are only slightly developed. The suckers are quadriserial.

The tentacular club is short (19%) with a well developed swimming-membrane extending beyond the base of the club; there is a narrow, ventral, protective membrane and a wide, dorsal, protective membrane, attaining in the middle half the width of the sucker-bearing surface.

In the middle of the club the small subequal suckers seem to be arranged in five longitudinal series, but perhaps form oblique transverse rows of eight.

This small animal (L=57 mm) was sexually mature, the nidamentary glands were well developed and the ovary was filled with eggs.

In his original description Adam (1939*a*, p. 5) described two types of shells which he considered to be male and female ones. This hypothesis is substantiated by the fact that the shell from Singapore (*f*) probably belongs to the female type specimen.

The shell of the male has a very flat median part with a narrow central rib. The whole dorsal surface is tuberculate and presents three, longitudinal series of stronger tubercles, one in the median line and two extending from the posterior end to the lateral angles of the acuminate, angular, anterior portion (this character which is very distinct in the original illustration, is not visible in the male shell figured on pl. 2, fig. 5).

The ventral surface is rather flat with a very shallow median groove. The striated zone is separated from the outer cone by two broad smooth areas, the striae being weakly rounded. The inner cone is rose-coloured and has broad lateral limbs which are nearly completely fused to the outer cone and to the smooth marginal areas. The posterior part of the inner cone forms a rounded, ventral ledge with a flat, thick, anterior rim. The outer cone is acuminate at its posterior end and interrupted between the inner cone and the spine. The latter is laterally compressed, has no keels and is slightly curved upwards (in one of the male shells from Madras (*c*) the spine is very slightly keeled ventrally).

The shell of the female differs in several respects from that of the male. It seems to be still more acuminate at the anterior end, whereas the posterior part is wider. The dorsal surface is more rounded and does not show the three series of stronger tubercles but only three ribs. The ventral surface has a wide groove and the striae are much more convex anteriorly. The inner cone is fused to the outer

[1] Since this memoir was set up in type, Adam (1965, p. 172) has re-examined the type specimens of *S. brevimana* Steenstrup, 1875, and found that the species was conspecific with his *S. winckworthi*. Here the older name *S. brevimana* is re-introduced for this species.

cone over a longer distance and only the extreme posterior part forms a ventral ledge, the flat thickened rim of which is less V-shaped and only weakly concave. The outer cone is broader.

Remarks: Adam (1939*a*, p. 7; 1939*c*, p. 80; 1944, p. 230, 231) discussed the status of this species and of *Sepia rostrata* Férussac & d'Orbigny in detail, as well as the close resemblance of the latter to *Sepia cottesloensis* (Cotton). Unfortunately neither Cotton (1940, p. 438), nor Iredale (1954, p. 79) have taken notice of this fact; the latter author only states that *Sepia rostrata* does not occur in Australia.

3. ***Sepia zanzibarica*** Pfeffer, 1884
(Pl. 2, figs. 9–11; pl. 41, fig. 247)

Sepia zanzibarica Pfeffer, 1884, p. 9, fig. 11, 11*a*; Smith, 1916, p. 21; Massy, 1925, p. 211; Tomlin, 1923, p. 40.

Type locality: Zanzibar.
Geographical distribution: East Africa (Massy, 1925); Natal (Smith 1916; Tomlin, 1923).
Material:

a. Madagascar (Coll. Bartlett); B.M. 1874.2.26.1; 1 shell.
b. Mombasa, 3.x.1950 (Coll. Selfe); B.M. 196352W.; 1 shell (certainly recovered from the animal) and 2 broken shells.

Measurements:

Shells (in % of shell-length)

Loc.	L. in mm	W.	Th.	Str.z.	Spine	Observations
b	184	31	10·6	71	2·7	pl. 2, figs. 9–11
a	163	34	9·2+	67	2·5	

Description: The complete shell from Mombasa is in excellent condition (pl. 2, figs. 9–11) The dorsal surface shows a distinct, but low, median rib and a slight indication of two lateral ribs. The chitinous margins are rather wide in the anterior half. The surface is strongly calcareous with reticulate granules in the posterior portion; these diminish gradually towards the anterior end. The spine is strong, slightly curved upwards, without keels but has long thick, smooth lateral expansions at its base. The ventral surface has a wide median groove over the whole length of the striated area; on both sides of this groove the surface is distinctly convex and the striae are reversed V-shaped. On both sides of the striated area there is a rather wide, nearly smooth, marginal zone, in the middle of which the limbs of the inner cone are situated. These limbs are rather narrow, fused to the outer cone in their anterior part, their outer border rising gradually as a rounded ridge which forms a long convex ledge as in *Sepia aculeata* in its posterior part.

The outer cone is well developed and continuous behind the inner cone as a very narrow chitinous margin, separating the inner cone from the base of the spine.

Remarks: The shell of *Sepia zanzibarica* resembles that of *S. aculeata* in its inner cone, that of *S. pharaonis* in the wide ventral groove and in the lateral expansions at the base of the spine.

It is certainly closely related to *Sepia thurstoni*, whose ventral surface is flatter and in which the limbs of the inner cone are much broader, whereas there are no lateral expansions at the base of the spine. The tentacular club of *Sepia thurstoni* is slightly different (see p. 4).

Compared with *Sepia lycidas*, the shell of *S. zanzibarica* is thicker with a shallower median groove; it lacks the glaze-like covering of the posterior part of the dorsal surface that is so noticeable in

S. lycidas. The latter has no lateral expansions at the base of the spine. The limbs of the inner cone are narrower and thicker and the posterior ledge is shorter in *S. lycidas*.

Massy (1925, p. 211) has described the hectocotylus, which is "situated on the distal third of the fourth left arm, where about six rows of suckers are arranged so as to leave a bare flattened surface with ridges bordered by a single row of suckers ventrally, while those of the dorsal side are crowded together". We presume that the hectocotylus is situated on the proximal third of the arm.

The female type specimen which has been examined by Adam presented the following relative measurements:—

M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I	A.L. II	A.L. III
168	89	42	21	32	92	9	30	30	33

M.L.d. in mm	M.L.v.	A.L. IV	T.L.	T.cl.	S.a.	S.t.
168	89	40	92	21	1·2	1·5

The buccal membrane has a single sucker on five of its tips.

The tentacular club has a narrow swimming-membrane, extending slightly beyond the base of the club. The tentacular stem is triangular in cross-section, keeled on the outer side, the keel not being continuous with the swimming-membrane of the club. The inner surface of the stem is flat or slightly concave with rounded keels at the margins. The club is short, oval, with narrow protective membranes which remain separated at the base of the club and continue down the stem as membraneous ridges. The suckers seem to be arranged in six longitudinal series, but probably form oblique transverse rows of eight (pl. 41, fig. 247); the second and third sucker of these rows being widest, the fourth and fifth being nearly as wide while the others are somewhat smaller; their chitinous rings are armed with numerous close-set teeth.

4. ***Sepia lycidas*** Gray, 1849
(Pl. 3, figs. 12–15; pl. 41, fig. 236)

Sepia lycidas Gray, 1849, p. 103; Hoyle, 1886, p. 24.
Sepiella lycidas, Rochebrune, 1884, p. 89; Adam, 1944, p. 225.
? *Sepia subaculeata* Sasaki, 1914, p. 609, pl. XII, figs. 6, 7; 1929, p. 173; pl. XVI, figs. 13, 14; pl. XVII, fig. 1; text fig. 104.

TYPE LOCALITY: Canton (market).

MATERIAL:

a. Canton market (Pres. Tradescant Lay); Gray No. 41*a*[1]; holotype, ♂ (?); B.M. 1963119W.
b. China (from the Chinese Court, International Fisheries Exhibition); B.M. 1884.2.21.17; 1 ♀.
c. Inland Sea, Japan (Coll. Gordon Smith); B.M. 1904.10.28.5; 1 ♀.
d. Sarawak, Borneo; B.M. 1894.7.14.5; 1 shell.

[1] This number refers to Gray's manuscript Catalogue (1849).

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
b	♀	200	88	50	29	27	–	–	34
c	♀	175	91	44	18	32	95	12	30

Loc.	Sex	M.L.d.	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
b	♀	200	34	40	48	160	25	1·5	0·85
c	♀	175	30	34	36	86	21	1·14	0·80

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
b	♀	198	37	9·6	76	1·5+	pl. 3, figs. 12 & 13
c	♀	174	35	8·6	80	2·9	
d	–	193	35	8·3	83	2·1	pl. 3, figs. 14 & 15

DESCRIPTION: The type specimen is in very poor condition; it is a salted market specimen, opened and devoid of its inner organs. Its tentacular club resembles that of the specimen from China (*b*) and the dentition of the suckers is exactly the same. The left ventral arm seems to be hectocotylized and of the same type as in *Sepia esculenta*. The shell is in very poor condition but belongs without any doubt to the same species as the other specimens.

The female specimen from China is better preserved. The dorsal mantle-margin is regularly rounded, projecting forward in the middle while the ventral margin is nearly straight. The siphon is very large reaching nearly up to the buccal membrane. The fins are contracted and distorted. The buccal membrane has a small sucker on each of its seven tips. The arm-suckers do not possess any teeth. The tentacular clubs are poorly preserved; each bears about eight rows of subequal suckers, armed with numerous fine denticles all around their chitinous rings.

The dorsal surface of the shell (pl. 3, figs. 12 & 14) is regularly convex with only a slight indication of a median rib. Its posterior portion is covered by a smooth glaze-like substance. The chitinous margins are not very broad. The ventral surface shows a broad median groove. Posteriorly the striae are regularly rounded but anteriorly they become more and more angular and the furrow broader and deeper. The inner cone surrounds a deep posterior pit. Its posterior margin is very thick and rounded, the lateral limbs become flatter and narrower near their anterior end which reaches to about one third of the shell-length. The outer cone is continuous between the inner cone and the base of the spine. The latter is small and damaged.

The female from the Inland Sea is in better condition. The fins begin at a few millimetres behind the mantle margin and extend beyond the posterior end of the mantle.

Some of the tips of the buccal membrane each have a single minute sucker.

The arms are stout; the dorsal and dorso-lateral ones are rounded on their outer sides, the ventro-lateral ones are laterally compressed with slight external keels, and the ventral ones are very stout, compressed, with strong external keels. All the arms are provided with narrow protective membranes.

The tentacular stem is triangular in cross-section, the inner side being flattened and the outer one keeled. The club has a well-developed swimming-membrane on the dorsal side, extending from the tip and reaching nearly to the base of the club (pl. 41, fig. 236). This membrane is situated midway

between the dorsal protective membrane and the outer keel of the stem which continues for a short distance up the club, without being connected with the swimming-membrane.

The two, narrow, protective membranes are not connected at the base of the club and continue as low, membraneous ridges down to the base of the stem. The tentacular suckers are subequal and arranged in eight longitudinal series. Most of the arm-suckers have their chitinous rings armed with numerous, narrow denticles, especially on their distal sides. The rings of the tentacular suckers show the same dentition all around.

The shell is similar to the one described on previous page. Its spine is straight without any keels. The anterior portion of the ventral surface is so flat that in lateral view it is hidden by the lateral margins.

The shell from Sarawak is less well preserved. Its anterior part is less flattened. The spine is curved slightly upwards. The outer cone does not seem to be continuous behind the posterior part of the inner cone, but it is damaged.

Remarks: *Sepia lycidas* was an insufficiently described species until we had the opportunity to examine the type. *Sepia subaculeata* Sasaki is probably identical with it. The only difference seems to be the relative length of the striated area of the shell, but Sasaki's figure (pl. XVI, fig. 14) represents a smaller specimen and in general the length of the striated zone becomes relatively longer with the growth of the animal.

The main differences between *Sepia lycidas* and *Sepia aculeata* are the ventral groove of the shell in the former species and the hollowed-out portion of the hectocotylus in the latter. The series of tentacular suckers are less numerous in *Sepia lycidas*.

5. ***Sepia savignyi*** Blainville, 1827

(Pl. 3, figs 16 & 17; Pl. 4, figs. 18 & 19; pl. 41, fig. 238 & pl. 42, fig. 249).

Sepia officinalis Audouin, in Savigny, 1827, p. 11, pl. I, fig. 3 (*non* Linné).
Sepia savignyi Blainville, 1827, p. 285; Férussac & d'Orbigny, 1848, p. 281, pl. IV (*Sepia Savigniana* Férussac); Adam, 1959, p. 142, fig. 6, pl. VIII.
Sepia savigni Rochebrune, 1884, p. 115; Adam, 1944, p. 235.

Type locality (neotype): Red Sea.
Geographical distribution: Red Sea.
Material:

a. John Murray Exped. St. 27, Gulf of Aden, 11°57′12″ N., 50°35′10″E., 12.x.1933, 15–40 fms., bottom, sand and shell; 1 ♀. B.M. 196353W.
b. Red Sea, Kameran Island, 9.iv.1936 (H.M.S. *Weston*, Coll. Bowen); 27.v.36 ; 1 ♀. B.M. 196354W.
c. Persian Gulf (Coll. Townsend); B.M. 1904.2.29.4; 1 shell.

Measurements:

Animals (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a	♀	88	93	55	34	39	–	11	33
b	♀	75	88	51	24	41	93	10·5	33

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	♀	88	35	39	41	152	28	1·14	1·60
b	♀	75	37	40	36	80	24	1·34	1·60

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
a	♀	88	41	10·2	64	–	pl. 4, figs. 18 & 19
c	–	70	44	10	60	±1·4	pl. 3, figs. 16 & 17

DESCRIPTION: The body is broadly oval and slightly acuminate behind; the mantle-margin projects bluntly in the middle of the dorsal side, it is concave behind the eyes and slightly emarginate ventrally.

All the arms are laterally compressed and have outer keels which are well developed on the ventro-lateral and ventral arms where they form distinct swimming-membranes.

The buccal membrane has a single minute sucker on some of its tips. The subequal arm-suckers are quadriserial.

The tentacles are long and slender with narrow clubs (pl. 41, fig. 238; Pl. 42, fig. 249).

The swimming-membrane is not very wide, hardly extending beyond the base of the club. The protective membranes are narrow, separated at the base of the club and continue down the flattened inner surface of the stem. The tentacular suckers are subequal (the middle ones are slightly larger), arranged in oblique, transverse series of eight, which gives the impression of only six longitudinal series. The arm-suckers have their rings each armed with about 15 rather long, irregular, more or less sharp teeth at their distal margin. The tentacular suckers are provided with the same type of teeth all round.

The shell from the Persian Gulf (*c*) is broadly oval, slightly acuminate at the anterior end, with a very short spine at the posterior end (pl. 3, figs. 16 & 17). The dorsal surface shows a very faint indication of a median and two, lateral, barely-raised ribs. Nearly the whole dorsal surface is granulous, reticulate in the posterior part and showing growth lines in the anterior half. The ventral surface is very flat, with a wide shallow groove in the middle of the striated zone; on the last loculus this groove is much narrower.

The striated zone is concave and flat in its posterior half and slightly convex on both sides of the median groove in its anterior part. The striae are regularly convex in the posterior area and bluntly angular in the anterior one. The striated zone is separated from the outer cone by two broad, nearly smooth, marginal areas. The limbs of the inner cone are situated nearly at the outer margin of these smooth areas; they are rather wide and nearly completely fused to the outer cone. Over a great part of their length, their outer margin is slightly raised as a flat cream-coloured ridge, which forms a somewhat broader flat ledge at the posterior end, surrounding a well-developed excavation.

The outer cone is broad in its lateral parts, continuous at its posterior end, forming a very narrow margin behind the inner cone.

The shell of the specimen from the Gulf of Aden (*a*) has the smooth marginal areas of the ventral side narrower and the limbs of the inner cone situated at the margins of the striated zone (pl. 4, fig. 19). The median groove is less developed, the lateral margins of the inner cone are stouter, and the posterior ledge more rounded. The spine is very small.

REMARKS: The animal of the specimen from the Red Sea (*b*) could be easily confused with *Sepia dollfusi*, especially as regards the tentacular club of the latter (pl. 41, fig. 237). It shows the same narrow ridges on the head.

Its shell is greatly damaged but the presence of a short spine, the remaining parts of the inner cone and the striated area leave little doubt that it belongs to *Sepia savignyi*.

Adam (1959, p. 144) has discussed in detail the status of this species, which has been confused with *Sepia pharaonis* by Férussac & d'Orbigny (1848, p. 281), and with *S. pharaonis*, *S. gibba* and *S. lefebrei* by Tryon (1879, p. 194, 279, 281 and 287).

6. ***Sepia aculeata*** Férussac & d'Orbigny, 1835–1848
(Pl. 4, figs. 20 & 21; pl. 42, fig. 251)

Sepia aculeata Férussac & d'Orbigny, 1835–1848, p. 287, pls. 5 *bis*, 25; Adam, 1939*c*, p. 67, pl. II, figs. 1–5; 1944, p. 237; Satyamurti, 1956, p. 179, pl. XXVI, fig. 4.
Acanthosepion aculeatum, Rochebrune, 1884, p. 101; Adam, 1944, p. 230.
Acanthosepion hasselti Rochebrune, 1884, p. 101; Adam, 1944, p. 230.
Sepia blainvillei Férussac & d'Orbigny, 1848, pl. 21 (*non* Deshayes, 1835).
Sepia indica Férussac & d'Orbigny, 1848, p. 288, pl. 21; Adam, 1939*c*, p. 76.
Acanthosepion indicum, Rochebrune, 1884, p. 112; Adam, 1944, p. 234.
Acanthosepion javanicum Rochebrune, 1884, p. 110; Adam, 1944, p. 233.
Sepia microcotyledon Ortmann, 1891, p. 673, pl. XLVI, fig. 1; Adam, 1939*c*, p. 77.
? *Sepia esculenta* var. ? Robson, 1932, p. 29.

Type species of *Acanthosepion* Rochebrune, 1884.
TYPE LOCALITY: Java.
GEOGRAPHICAL DISTRIBUTION: Indo-Pacific (see Adam, 1939*c*, p. 67, 70).

Sasaki (1929, p. 173) mentions that this species occurs as far north as Formosa, but doubts Wülker's (1910, p. 11) and Berry's (1912, p. 418) references for Japan as "the species may be easily confounded with *S. subaculeata* Sasaki".

MATERIAL:

ANIMALS

a. Bombay (from the Bombay Government exhibit, International Fisheries Exhibition, 1883); B.M. 1883.10.27.27; 1 ♀.
b. Singapore, fish market (Pres. Director, Raffles Museum); B.M. 1947.5.16.6; 1 ♂ (det. Robson, 1923).
c. Batavia (Brandts Coll. Purchased from Krantz, Berlin); B.M. 1855.12.19.5: 1 ♂.
d. Penang (East India Museum, Coll. Cantor); B.M. 1860.6.2.86; 1 ♂.

SHELLS

e. Cochin; B.M. 1879.12.26.131; 1 sp.
f. Sarawak, Borneo; B.M. 1894.7.14.4; 1 sp.
g. Singapore (Coll. Archer); B.M. 1908.12.22.19; 1 sp.
h. Hambantota (Winckworth, 16. xii.1926); B.M. 1952.12.30.32–33; 2 sp.
i. Madras (Winckworth, 23.x.1927); B.M. 1952.12.30.35–38; 4 sp.
j. Ennūr (Winckworth, 13.ii.1925); B.M. 1952.11.24.50; 1 sp. (♀)
k. Jahu Beach, Bombay (Winckworth, 4.xi.1928); B.M. 1952.11.24.51–53; 3 sp.
l. Dighe (Winckworth, March, 1929); B.M. 1952.11.24.54–55; 2 sp.
m. Dighe (Winckworth, 15.iii.1929); B.M. 1952.12.30.56–57; 2 sp.
n. Mannar (Winckworth, 30.xii.1924); B.M. 1952.11.24.60; 1 sp.
o. Jahu (Winckworth, 4.xi.1928); B.M. 1952.11.24.61; 1 sp.
p. Karwar (Winckworth, Feb., 1944); B.M. 1952.12.30.67–68; 2 sp.
q. Madras (Winckworth, 17.xii.1928); B.M. 1952.11.24.92; 1 sp.
r. Madras (Winckworth, 6.vi.1924); B.M. 1952.11.24.96; 1 sp.
s. Mannar (Winckworth, 30.xii.1924); B.M. 1952.11.24.97–98; 2 sp.
t. Madras (Winckworth, 12.i.1936); B.M. 1952.11.24.166; 1 sp. (♂)

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
d	♂	113	89	43	24	35	94	9·5	44
b	♂	43	91	53	23	46	93	16	42

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
d	♂	113	49	51	51	102	26	1·6	0·58
b	♂	43	40	42	46	–	–	1·4	-

SHELLS (IN % OF SHELL-LENGTH)

Loc.	L. in mm	W.	Th.	Str.z.	Spine
a	170	36	10	72	–
f	162	35	9	77	3·1
k^1	162	33	9	71	3·4
j	161	37	8	74	3·7
k^2	160	33	8	72	3·4
k^3	157	35	9	67	3·5
h	143	34	12	63	3·5
p^1	140	33	7	78	2·9
e	137	34	9	73	2·9
t	136	29	8	79	–
m^1	124	34	9	69	4·0
l^1	115	36	8	64	3·9
d	112	34	9	73	3·4
l^2	107	32	8	75	3·7
q	106	33	9	73	4·2
g	104	31	–	57	–
n	97	32	9	61	4·6
p^2	94	35	9	61	4·8
m^2	94	33	8	74	4·8
i^1	90	34	11	61	4·5
i^2	78	36	10	61	4·5
i^3	67	39	10	51	6·0
s^1	55	38	10	51	6·4
o	48	40	9	–	8·3
s^2	46	38	9	52	6·5
b	43	40	10	53	4·9
i^4	34	43	9	59	7·3

DESCRIPTION: This material agrees with the specimens described by Adam (1939*c*, p. 67). The male from Penang (*d*) is well preserved. Its dorsal arms are rounded on the outer sides, the lateral ones have slight keels and the ventral ones have strong swimming-membranes. The tentacular stem is triangular in cross-section being keeled on the outer side and flattened at the inner one, with two lateral ridges, these being the continuation of the protective membranes of the club. The swimming-membrane of the latter (pl. 42, fig. 251) is shorter than the sucker-bearing surface and is not connected with the outer keel of the stem. The small subequal suckers are arranged in 12 longitudinal series. Some of the tips of the buccal membrane possess a few minute suckers each. The hectocotylus has about 12 normal suckers at the base, followed by six rows of very small suckers.

In the middle of the dorsal half of the hectocotylized portion is a nearly circular, hollowed-out space, about 2·5 mm in diameter. This feature is not visible in the smaller male (*b*).

The dorsal surface of the shell (pl. 4, figs. 20 & 21) has three distinct low ribs and very narrow chitinous margins. It is rugose and the posterior end is glaze-like.

On the ventral surface the striate zone is slightly convex, except at the posterior end, where it is concave. The last loculus is very short, and slightly concave in the middle.

The striated zone is separated from the outer cone by two wide, smooth, lateral areas; the limbs of the inner cone being situated on these smooth areas. The inner cone is partly applied to the outer cone, but its posterior portion forms a thick, rounded ledge which surrounds the posterior excavation. The outer cone forms only a narrow, chitinous ledge between the inner cone and the spine. The latter is slightly turned upwards and has no keels.

The other animals are in poor condition. The male from Batavia (*c*) shows the characteristic hollowed-out portion of the hectocotylus.

Some of the shells show a very slight median groove on the striated area, but it may be completely lacking.

If we combine this description with the detailed description given by Adam (1939*c*, p. 67) we can summarize the typical characters of this species as follows:—

Tentacular club: subequal, minute suckers arranged in 10 to 12 longitudinal series in the male, in 13 to 14 series in the female.

Hectocotylus: three groups of normal suckers at the base; transformed portion with four to six transverse rows of four very small suckers, the dorsal ones being situated in a deep rounded groove.

Buccal membrane: tips provided with few minute suckers.

Arm suckers: quadriserial, more globular in the male than in the female.

Cuttlebone: Dorsal surface rugose with three ribs, posterior portion covered by glaze-like substance; ventral surface with convex striated area, inner cone with strong, rounded, ventral ledge; spine without keels.

Remarks: Earlier Adam (1939*c*, p. 78) considered *Sepia smithi* Hoyle, 1885, as a synonym of *Sepia aculeata*. His opinion was based principally on the original figures and description, but he overlooked the fact that Hoyle (1886, p. 125) described the striated area of the shell as being "excavated" which is certainly not the case in *Sepia aculeata*. On the other hand the tentacular club of *Sepia smithi* has a much greater number of longitudinal series of even smaller tentacular suckers.

In his description, Hoyle did not state the number of series of these suckers and his figure (pl. XVI, fig. 3) gives an erroneous impression of it. On p. 19 we give a re-description of *Sepia smithi*.

7. ***Sepia elliptica*** Hoyle, 1885
(Pl. 5, figs. 24–27; pl. 43, fig. 258)

Sepia elliptica Hoyle, 1885, p. 189; 1885*a*, p. 293; 1886, p. 131, pl. XIX, figs. 14–24; Brazier, 1892, p. 13; Massy, 1916, p. 226; Adam, 1939*c*, p. 72.

Acanthosepion (*Fiscisepia*) *ellipticum adjacens* Iredale, 1926*a*, p. 239, pl. XXXV, figs. 5 & 6; 1954, p. 77;[1] Iredale & McMichael, 1962, p. 99.

Acanthosepion ellipticum, Iredale, 1954, p. 77.[1]

Type localities:

a. Challenger Sta. 188, 9°59′S., 139°42′E., Arafura Sea, S. of Papua, 10.ix.1874, 28 fms.; gn. m.

[1] It is not clear from Iredale's text (1954, p. 77) whether he considers the specimens from these Australian localities as belonging to the typical form or to the sub-species (see next page).

b. Challenger Sta. 190, 8°56′S., 136°5′E., Arafura Sea, S. of Papua, 12.ix.1874, 49 fms.; gn. m.

GEOGRAPHICAL DISTRIBUTION: Arafura Sea, S. of Papua; Ganjam Coast; Arabian Sea; Queensland; Pellew Group, Gulf of Carpentaria; Melville Island, Northern Territory; N.W. Australia.[1]

Sub-species *adjacens:* Capricorn Group, S. end of Great Barrier Reef; Clarence River beach, N.S. Wales.

MATERIAL:

a. Challenger Sta. 188; B.M. 1889.4.24.71–72: 2 syntypes, ♂ and ♀

b. Challenger Sta. 190; B.M. 1889.4.24.73–74: 2 syntypes, ♂ and ♀

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
b	♂	72	88	53	22	44	97	14	37
	♀	54	89	59	27	50	96	15	31

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
b	♂	72	40	42	44	118	14	1·7	0·28
	♀	54	35	35	39	120	15	1·3	0·37

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
a	♂	44	48	9·8	63	–	
b	♂	72	42	10·2	61	–	pl. 5, figs. 24 & 25
	♀	54	47	10·6	58	–	pl. 5, figs. 26 & 27

DESCRIPTION: The original description was based on eight specimens, two males and six females; Massy (1916, p. 227) mentioned these as being in the British Museum, but we found only four of them.[2]

The tentacular club (pl. 43, fig. 258) is covered with minute suckers, which are arranged in about 10 to 12 series in the middle, and not in eight series as described by Hoyle (1886, p. 132). The protective membranes are connected at the base of the club by a membraneous ridge so that the club is distinctly separated from the tentacular stem.

The hectocotylus is only slightly modified. At the base of the left ventral arm seven or eight transverse series of suckers are normal; on the middle portion seven transverse rows have the two ventral suckers slightly smaller while the dorsal ones are considerably smaller than the normal ones; the distal part of the arm is normal. The transformed portion of the hectocotylus measures about 6 mm in length. The larger male is mature, with spermatophores protruding from the penis.

The shells are represented on pl. 5, figs. 24–27; these show all the important details. In both figured specimens the spine is broken; the remaining basal part is rounded, without any keels.

[1] See footnote on previous page.

[2] It was customary for the author to retain a part of the collection either for his own reference or for deposit in another institution; this applies particularly to *Challenger* Cephalopoda.

Remarks: In 1939, Adam (p. 72) expressed his opinion that *Sepia elliptica* might be the young stage of *Sepia esculenta*.

The described animals, on previous page, are sexually mature, but in the *Sepiidae* the animals often continue their growth, even to a considerable size, after having attained their sexual maturity for the first time.

In both figured shells of *Sepia elliptica* there is a large unstriated area between the striated zone and the base of the outer cone, the limbs of the inner cone being situated approximately in the middle of these smooth areas. In *Sepia esculenta* the latter are much narrower, but we have seen only much bigger specimens of this species and it is possible that this character changes gradually with the growth of the shell. The striated zone of *Sepia esculenta* is relatively longer and the outline of the striae becomes more and more acutely angular, which is probably also a character linked with age.

We do not see any reason for separating these species specifically, but the study of a great number of specimens may reveal sub-specific differences in relation to geographic distribution.

The shell of *Sepia elliptica* also appears to have some affinity with *Sepia brevimana* Steenstrup, especially as regards the inner and outer cone. The ventral surface of the shell of the latter species is flatter, the sculpture of the dorsal surface is different (see Adam, 1939*c*, pl. III, figs. 7–9) and the anterior margin is more acuminate. In *Sepia brevimana* the tentacular club has only five series of small subequal suckers. As in the shell of *Sepia officinalis* the posterior portion of the dorsal surface is covered in *Sepia elliptica* by a shiny glaze-like substance, which does not exist in *Sepia brevimana*.

According to Sasaki (1929, p. 179) the specimens reported by several authors from Japan probably all belong to *Sepia robsoni* Sasaki, 1929 (*non* Massy, 1927), which Adam (1939*c*, p. 77) renamed *Sepia madokai*. But if *Sepia elliptica* is really identical with *Sepia esculenta*, which seems to be a common Japanese species, it is difficult to understand why Sasaki never saw *Sepia elliptica* among the thousands of specimens of *Sepia* which he examined. As we do not have enough Japanese material at our disposal, we cannot take a final decision on this matter.

As to the subspecies *adjacens*, described by Iredale (1926*a*, p. 239), the author states that its shell is larger than in *Sepia elliptica*, the ventral wall of the inner cone more pronounced, the unstriated area of less extent and the dorsal sculpture less marked. In a later paper, Iredale (1954, p. 77) states the measurements of the subspecies as being 105 × 46 mm. As Adam (1939*c*, p. 72) pointed out, Iredale's subspecies *adjacens* resembles even more closely *Sepia esculenta*.

Because of the cup-like formation of the inner cone, the outer edge of which is, as it were, hinged in front, Iredale (1926*a*, p. 239; 1954, p. 77) created a new sub-genus *Fiscisepia* for *Sepia elliptica*. But as *Sepia esculenta* shows exactly the same formation of the inner cone, *Fiscisepia* Iredale, 1926, becomes a synonym of *Platysepia* Naef, 1923.

8. ***Sepia ? whitleyana*** (Iredale, 1926)
(Pl. 6, figs. 28 & 29)

Acanthosepion whitleyanum Iredale, 1926, p. 195, pl. XXIII, figs. 9 & 10; 1954, p. 76; Iredale & McMichael, 1962, p. 99.

Type locality: Port Macquarie, New South Wales.
Geographical distribution: New South Wales; Queensland; Great Barrier Reef.
Material:

a. Caloundra, Queensland (Pres. Cotton); B.M. 1962255W; 1 shell.

Measurements:

	Shell (in % of shell-length)				
L. in mm	W.	Th.	Str.z.	Spine	Observations
89	42	9·2	74	5·1	pl. 6, figs. 28 & 29

DESCRIPTION: The shell is broadly oval and rounded at both ends. The dorsal surface is regularly rounded and provided with a broad, low, median rib and two less distinct lateral ribs. The surface is granulous, the granules being arranged along the growth lines. The extreme posterior part is smooth and shiny but not covered by a glaze. The chitinous margins are narrow. The spine is rounded, without any keels and distinctly curved upwards.

The ventral surface is somewhat worn: it seems to be rather flat with a broad but shallow ventral depression. The striae are little convex in the posterior part of the striated area, becoming more and more reversed V-shaped in the anterior part. On both sides of the striated area there is a narrow smooth zone.

The lateral limbs of the inner cone are rather broad and completely fused with the outer cone. The posterior part is raised as a flat, rather thin ledge with a nearly straight transverse margin, the rim of which is thickened. From the latter a few ribs radiate towards the outer cone, the one situated in the median line being the most developed.

The outer cone is rather broad in the posterior half of the shell; it is continuous between the inner cone and the spine. The posterior part of the inner cone surrounds a deep excavation.

REMARKS: This shell has been identified by Cotton and we hope that this identification is correct. It is very useful to see the structure of the inner cone which was only vaguely indicated in the original figure.

In many respects this shell resembles that of *S. thurstoni*, but its mid-dorsal rib is much broader. In *S. whitleyana*, the smooth zones of the ventral surface are narrower, as also are the limbs of the inner cone. In *S. thurstoni* the posterior ledge of the inner cone is much thicker and rounded and the median groove of the striated area is deeper.

In some respects *S. whitleyana* resembles *S. brevimana*, but the shell of the latter is much more acuminate at both ends; its inner cone is very similar but lacks the radiating ribs.

But most of all, this shell resembles that of *S. elliptica*, especially of the male (see pl. 5, figs. 24–27); the only difference being the striated area which seems to be longer in *S. whitleyana* but as this part is worn it is not possible to be sure about this feature. The resemblance is so close, especially as regards the inner cone, that we do not hesitate to identify it with *S. elliptica*. This means that if Cotton's identification is correct we consider *S. whitleyana* a synonym of *S. elliptica*, but without having examined the type of the former species, we do not wish to take a final decision.

The original description of *S. whitleyana* fits the above described specimen fairly well. In his original description Iredale (1926, p. 195) states that the dimensions are 168 × 65 mm; in his later description (1954, p. 76) he mentions them as being 168 × 56 mm. Compared with the figure, the former statement seems to be the correct one. The largest specimen, collected opposite Bribie Island, Queensland, measured 235 × 78 mm (W. = 33%), a series from Michaelmas Cay: 26 × 10 (W. = 38%), 30 × 14 (W. = 47%), 34 × 18 (W. = 47%), 43 × 20·5 (W. = 48%), 50 × 21 (W. = 42%), 90 × 34 (W. = 38%), 102 × 41 (W. = 40%) and 114 × 42 (W. = 37%); thus the width of the shell seems to vary a great deal. In his later description, Iredale (1954, p. 76) states that: 'A notable feature of this species is the broad smooth band at each side of the striated area . . .' but 'in the figure the broad band at the side is not emphasized'. In the original description, Iredale does not mention a chitinous covering of the posterior part of the dorsal surface, but in 1954 (p. 76) he states that 'in drying, as noted previously, the horny covering at the base of the spine contracts, and causes the spine to break off, carrying the horny hood with it'. Thus the absence of the chitinous covering in dry shells can not be used as a reliable character. It is noteworthy that in Cotton's specimen, there is no trace of any chitinous covering and the spine is undamaged.

9. ***Sepia esculenta*** Hoyle, 1885
(Pl. 6, figs. 30–33; pl. 43, fig. 263)

Sepia esculenta Hoyle, 1885, p. 188; 1885*a*, p. 291; 1886, p. 129, pl. XVII, figs. 1–5; pl. XVIII, figs. 1–6; Sasaki, 1929, p. 175, pl. I, fig. 5; pl. XVI, figs. 15–17; Adam, 1939*c*, p. 73, pl. IV, figs. 9 & 10; Yasuda, 1951, pp. 350–356; Voss, 1962, p. 3; 1963, p. 28, pl. 2, figs. 2*a* & *b*; text-figs. 2*a* & *b*.
Platysepia esculenta, Naef, 1923, p. 546.
? *Sepia hoylei* Ortmann, 1888, p. 650; Berry, 1912, p. 419; Adam, 1939*c*, p. 75.
Diphtherosepion Dabryi (pars) Rochebrune, 1884, p. 81; Adam, 1944, p. 221.

TYPE LOCALITIES: Yokohama market (*S. esculenta*); Japan (several localities) (*S. hoylei*).
GEOGRAPHICAL DISTRIBUTION: Japan.
MATERIAL:

a. Yokohama market, Japan; B.M. 1889.4.24.69–70: 2 syntypes, ♂ and ♀.
b. Inland Sea, Japan (Pres. Gordon Smith); B.M. 1904.10.28.3–4; 1 ♂, 1 ♀.

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a	♂	160	87	47	22	36	94	12·5	36
a	♀	143	87	49	28	36	92	12·5	42
b	♂	130	90	45	35	36	94	13	36
b	♀	148	92	39	19	33	96	13	29

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	♂	160	41	39	41	–	–	1·6	–
a	♀	143	41	41+	44	–	–	1·7	–
b	♂	130	38	40	46	77	18	1·5	0·61
b	♀	148	30	32	35	–	15	1·4	0·61

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
a	♂	158	33	8·9	76	3·2+	pl. 6, figs. 30 & 31
a	♀	142	39	9·1	81	2·1+	pl. 6, figs. 32 & 33
b	♀	147	35	8·2	83	–	

DESCRIPTION: The type specimens agree with the original description. Unfortunately their tentacles are lacking. In the specimens from the Inland Sea the tentacular club possesses twelve longitudinal series of minute subequal suckers (Pl. 43, fig. 263). The swimming-membrane extends a little beyond the base of the club. The protective membranes are rather narrow, separated at the base of the club, and continue down the stem as faint membraneous ridges.

The dorsal surface of the mantle shows a series of six or seven, elongate, membraneous papillae along the base of each of the fins.

In the male type the hectocotylus has at its base five transverse series of four normal suckers, followed by five or six series of smaller ones. The male from the Inland Sea has eight series of normal basal suckers and five or six series of smaller ones. The hectocotylized portion occupies the distal half of the proximal third part of this arm.

The shell is very flat, its dorsal surface is granulous with three longitudinal ridges and is covered at the posterior end by a glaze-like substance. The ventral surface has a broad, median furrow. The striae are convex at the posterior end of the striated area becoming more and more angular towards the anterior end. There is a more or less smooth area at both sides of the striated zone. The broad limbs of the inner cone are nearly completely fused with the outer cone, except for the posterior portion which forms a thin ventral ledge with a thicker, rounded, anterior rim. The outer cone is interrupted between the inner cone and the posterior spine.

Remarks: Except for two records, this species has only been reported from Japan. Hedley (1906, p. 463) mentioned a specimen from Queensland, but according to Iredale (1926*a*, p. 239) it belongs to a quite different species which this author described as *Ponderisepia eclogaria* and which he reported from Fiji, New Hebrides, New Caledonia and North Queensland. As for the specimen from Singapore market which Robson (1932, p. 29) mentioned with some doubt as a variety of *Sepia esculenta*, it belongs probably to *Sepia aculeata* (see Adam, 1939*c*, p. 74).

According to Sasaki (1929, 176), *Sepia hoylei* Ortmann is probably identical with *Sepia esculenta*.

On p. 16 we discussed the resemblance between *Sepia elliptica* and *Sepia esculenta*. In the former species the protective membranes of the tentacular club are connected at its base by a membraneous ridge so that the club is distinctly separated from the tentacular stem. This character seems to be lacking in *Sepia esculenta*.

More material is necessary to establish the relationship between these species.

10. ***Sepia smithi*** Hoyle, 1885
(Pl. 7, figs. 34 & 35; pl. 41, fig. 239)

Sepia smithi Hoyle, 1885, p. 190; 1886, pp. 21, 124; pl. 16, figs. 1–12; Brazier, 1892, p. 11; Adam, 1939*c*, p. 78; Iredale, 1954, p. 77.

Type locality: Challenger Sta. 188, 9°59′S., 139°42′E., Arafura Sea, S. of Papua, 10.ix.1874, 28 fms.; gn. m.

Material:

a. Syntypes, 2 ♀ ♀ ; B.M. 1889.4.24.66–67.

Measurements:

Animals (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a	♀	85	92	46	29	39	94	12	35
	♀	57	90	49	26	46	91	14	32

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	♀	85	33	35	47	94	22	1·2	0·3
	♀	57	35	39	42	97	24	1·2	0·3

Shells (in % of shell-length)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
a	♀	81	37	7·4	72	–	pl. 7, figs. 34 & 35
	♀	55	40	7·3	69	3·6+	

DESCRIPTION: Both animals agree fairly well with the original description. At the base of the fins, the dorsal mantle surface shows five or six, elongate, membraneous papillae; the rest of the surface is covered with small, widely-spaced, round papillae.

The tentacular stem is triangular in cross-section, with a blunt outer keel, the inner side is flattened and bears two, narrow, membraneous ridges, these being the continuation of the protective membranes of the club. The swimming-membrane of the latter extends to its base; it is situated on the dorsal side and is not continuous with the outer keel of the stem. The club is covered with numerous long-stalked suckers, arranged in about 20 longitudinal series (Pl. 41, fig. 239). The two protective membranes are not connected at the base of the club.

There are no suckers on the buccal membrane.

The shell has been well described but the original figure is not very detailed and does not show the exact form of the inner cone. The specimen figured by Hoyle has not been found in the collection of the British Museum. Both the above-mentioned specimens differ from the original figure in the striated area, which is much longer with a more angular outline of the striae and a distinctly wider median groove.

The spine of the larger specimen is broken, but according to Hoyle's description (p. 126) it 'curves gently upwards'. The last loculus is 27% of total shell length in the smaller specimen and 24% in the larger one, whereas Hoyle (p. 125) states and figures it as 29·5%.

The inner cone is well-developed with a rather thick posterior ledge, surrounding the posterior pit. The lateral limbs are applied to the outer cone and form rounded ridges which disappear gradually anteriorly.

REMARKS: The above-described shells show a close resemblance to the one we compared with *Sepia pageora* (p. 22).

As we mentioned on p. 14, Adam (1939*c*, p. 78) was mistaken in considering *Sepia smithi* to be synonymous with *Sepia aculeata*. If the specimen figured by Hoyle (1886, pl. 16, figs. 1–12) belongs to the same species as the above-mentioned syntypes, *Sepia smithi* is a distinct species, perhaps identical with the specimen from Cape Upstart which we compared with *Sepia pageora* (p. 22).

11. ***Sepia pageora*** (Iredale, 1954)
(Pl. 7, figs. 36–37; pl. 42, fig. 253)

Sepia indica Gray, 1849, p. 108 (*non* d'Orbigny, 1848).
Acanthosepion pageorum Iredale, 1954, p. 76, pl. IV, figs. 7–9.

TYPE LOCALITY: Keppel Bay, Queensland.

GEOGRAPHICAL DISTRIBUTION: Queensland, Melville Island, Northern Territory, Timor Sea, Broome, Port Cloates, Shark Bay.

MATERIAL:

a. Cape Upstart, Australia (Pres. Jukes); Gray No. 30*a*; 1 ♂. B.M. 1963118W.

MEASUREMENTS:

			ANIMAL (IN % OF DORSAL MANTLE-LENGTH)						
Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a	♂	100	89	50	30	38	95	13	50

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	♂	100	48	60	60	130	33	1·5	0·25

SHELL (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
a	♂	99	34	7·6	82	3·5	pl. 7, figs. 36 & 37

DESCRIPTION: The dorsal mantle-margin projects forward, reaching up to the mid-level of the eyes.

The arm-suckers are quadriserial, each armed with numerous long denticles especially on the distal side of the chitinous ring. There are no suckers on the buccal membrane.

The tentacular stem is more or less triangular in cross-section with an outer keel. The swimming-membrane does not reach the base of the club; it is situated on the dorsal side and is not connected with the keel of the stem. The narrow protective membranes are separated at the base of the club and continue down the stem as faint ridges. The club is covered with numerous, minute, long-stalked suckers, the rings of these being armed with sharp denticles all around their rims (pl. 42, fig. 253).

The hectocotylus has about eight transverse rows of normal suckers at its base; these are followed by about eight transverse rows of very small suckers, the distal half of the arm being normal.

The shell (pl. 7, figs. 36–37) has a granulous dorsal surface with three distinct longitudinal ribs. The outer margin is chitinous and the posterior part covered with a glaze-like substance.

The ventral surface is flat with a broad, median groove on the striated area; the striae are regularly rounded in its posterior portion but are more and more angular in the anterior part. On both sides of the striated area there is a broad smooth zone. The inner cone is mostly reflected and fused with the outer cone; there is only a thin posterior ridge, surrounding a shallow, posterior depression. The posterior part of the outer cone is wide and continuous behind the rim of the inner cone. The spine is devoid of keels and turned upwards in a regular curve.

REMARKS: This specimen, which Gray (1849, p. 108) identified as *Sepia indica*, certainly does not belong to this species. The shell resembles *Sepia esculenta* very closely and without having examined the animal we would have been inclined to consider it as belonging to this species. But the tentacular club with its numerous minute suckers is undoubtedly different.

The only species which seems to possess a similar shell is *Acanthosepion pageorum* Iredale. The latter species seems to be closely related to *S. whitleyana*, but the posterior part of the inner cone is different and in the specimen we examined of this species there was not a trace of the glaze-like covering on the posterior part of the dorsal surface. As regards the latter feature we refer to our remarks on *S. whitleyana*.

In his introduction to the description of *Acanthosepion pageorum*, Iredale (1954, p. 76) states: "When a common species is well known it has been found that the sexual variation is small and inconstant, and bones cannot be separated into male and female. Apparently in the species of *Acanthosepion* and allied genera there are, however, in many cases, narrow and broad shells, and until animals are studied in series no decision can be made. At the present these are not separated, but regarded as belonging to one species, although this conclusion is open to doubt." As he never described a single animal of the numerous species he created, we wonder how he found that the sexual variation is small and inconstant. In some cases as in *S. brevimana* the bones of males and females

can certainly be separated, unless of course one starts by considering the males and the females as belonging to different species, or if the fact that young specimens have relatively broader bones than older ones is not taken into consideration.

The type-specimen of *S. pageora* measured 135 × 50 mm (W. = 37%); a series from Lindeman Island, Queensland: 58 × 24 mm (W. = 41·5%), 90 × 33 mm (W. = 36%), 124 × 42 mm (W. = 34%), 146 × 51 mm (W. = 35%). A narrow bone from the Timor Sea measured 120 × 39 mm (W. = 32·5%), a broad one from Point Cloates 140 × 50 (W. = 35·5%), and an immature one from Shark Bay 60 × 25 mm (W. = 41·5%). These differences are in any case insignificant. According to the author a bone from Bucasra Beach, near Mackay, Queensland, which measured 110 × 43 mm (W. = 39%), may represent a different form as the dorso-posterior chitinous hood is glistening white, whereas all the other specimens from Queensland show a yellow hood.

If the specimen from Cape Upstart really belongs to *S. pageora*, this species is probably identical with *S. smithi* Hoyle (see p. 20).

12. ***Sepia pharaonis*** Ehrenberg, 1831
(Pl. 8, figs. 38–43; pl. 41, fig. 240)

Sepia pharaonis Ehrenberg, 1831, p. (?); Adam, 1941, p. 5, pl. II, fig. 1; 1959, p. 130, fig. 2, pls. I–III, IV, fig. 3; 1960, p. 3; Voss, 1963, p. 20, pl. I, figs. *b*, *c* & text-fig. 1*f*, *g*.
Sepia rouxii Férussac & d'Orbigny, 1841, p. 271, pl. 19; Adam, 1939*c*, p. 56, pl. I, fig. 4; pl. II, figs. 6 & 7; Satyamurti, 1956, p. 179, pl. xxvi, fig. 3.
Acanthosepion rouxi, Rochebrune, 1884, p. 108; Adam, 1944, p. 232.
Sepia torosa Ortmann, 1888, p. 652, pl. XXIII, fig. 2; Sasaki, 1929, p. 163, figs. 100 & 101; pl. XVI, fig. 11; Adam, 1939*c*, p. 61.
Sepia framea Ortmann, 1891, p. 675, pl. XLVI, fig. 2; Adam, 1939*c*, p. 62.
Sepia singalensis Goodrich, 1896, p. 3, pl. I, figs. 4–8; Adam, 1939*c*, p. 62.
Ascarosepion singhalensis var. *foxi* Robson, 1927, p. 325.
Sepia koettlitzi Hoyle & Standen, 1901, p. 1, pl. I; Adam, 1939*c*, p. 63.
Sepia formosana Berry, 1912, p. 420, fig. 2, pl. IX, fig. 7; Sasaki, 1929, p. 165, figs. 165 & 166, pl. XXX, figs. 9–11; Adam, 1939*c*, p. 64.
Crumenasepia hulliana Iredale, 1926, p. 239, pl. XXXV, figs. 1 & 2; 1954, p. 77.
Sepia hulliana, Adam, 1939*c*, p. 65.
Sepia tigris Sasaki, 1929, p. 168, fig. 167, pl. XXVIII, figs. 13–16; Adam, 1939*c*, p. 65.
Crumenasepia ursulae Cotton, 1929, p. 90, pl. XV, figs. 3 & 4.
Sepia ursulae, Adam, 1939*c*, p. 66.
Sepia (*Crumenasepia*) *ursulae*, Cotton & Godfrey, 1940, p. 434, fig. 421.
? *Sepia venusta* Pfeffer, 1884, p. 12, figs. 15 & 15*a*; Hoyle, 1905, p. 982 (*non* Münster, 1837).
? *Sepia venustoides* Hoyle, 1909, p. 266 (=*Sepia venusta* Pfeffer).
Sepia sinope, Voss, 1962, p. 3 (*non* Gray, 1849).

TYPE LOCALITIES: Tor, Sinai; Massaouah (*S. pharaonis*); Bombay; Red Sea (*S. rouxii*); Tokyo Bay (*S. torosa*); Ceylon (*S. framea*); Colombo; off Point de Galle (*S. singalensis*); Zeila, nearly opposite to Aden (*S. koettlitzi*); Takao, Formosa (*S. formosana*); Howick Island, North Queensland (*S. hulliana*); Taihoku market, Formosa (*S. tigris*); Cottesloe, Rottnest Island (*S. ursulae*); Kabret; Port Taufiq (*S. singhalensis* var. *foxi*); Zanzibar (*S. venusta*).

GEOGRAPHICAL DISTRIBUTION: Indo-Pacific, from the Red Sea to Japan and to Australia.

MATERIAL

a. Red Sea (McAndrew); B.M. 1869.6.14.1. (det. Hoyle as *Sepia koettlitzi*); 1 ♀ shell (114 × 42 mm) (Hoyle, 1901, pl. I, fig. 2).
b. Madras Coast, Indian Museum; B.M. 1879.12.26.129–130; 2 shells (L_M = 250+ and 260+ mm).
c. Celebes (from Bleeker Coll.); B.M. 1880.1.17. 5; 1 spec. (macerated).

d. ? Madras (Pres. F. Day); B.M. 1891.8.20.1; 1 ♀ (poor condition).

e. Sarawak, Borneo; B.M. 1894.7.14.3; 1 shell.

f. Ramashveran, Gulf of Mannar (Thurston, 1888); 1 ♂, 1 ♀ (poor condition). B.M. 196359W.

g. Suez, Nov., 1904 (W.E.H. No. 1075); B.M. 1947.5.5.43. (det. Hoyle as *Sepia rouxi*); 1 ♂ and remains of two shells.

h. Somaliland; B.M. 1903.1.2.1; 1 broken shell (type of *Sepia koettlitzi*).

i. Aden Beach, 2.iii.1925; B.M. 1921.11.24.26. (det. Winckworth as *Sepia singalensis*); 1 shell.

j. Kabret, Suez Canal; B.M. 1926.4.8.6; 1 ♀ (Holotype of *Ascarosepion singhalensis* var. *foxi* Robson, 1927).

k. Port Taufiq, Suez Canal; B.M. 1926.4.8.5; 1 juv. sp. (paratype of *Ascarosepion singhalensis* var. *foxi* Robson, 1927).

l. Hambantota, Gulf of Mannar, 16.xii.1926; 1 shell. B.M. 1952.11.24.6.

m. John Murray Exp. Sta. 27, Gulf of Aden, 10°57′12″N., 50°35′00″E.; 12.x.1933, 37–91 m., s. and sh.; 1 ♂. B.M. 196355W.

n. John Murray Exp. Sta. 37, Gulf of Aden, 12°47′30″N., 45°04′30″E., 17.x.1933, 18–22 m., s.; 1 ♂. B.M. 196356W.

o. Hong Kong, 8.x.1938; 1 ♂. B.M. 196357W.

p. Hong Kong, 15.x.1938; 2 ♂, 1 ♀. B.M. 196358W.

q. Two miles south of Point de Galle (Sta. XXXIX); B.M. 1947.5.5.34 & 35. (det. Hoyle, 1904 as *Sepia singalensis*); 2 ♀.

r. Yedda, Arabia (Pres. Trott); B.M. 1947.12.9.1; 1 ♀ (rather poor state).

s. Mukalla, S. Arabia, Dec., 1948 (Coll. Fraser-Brunner); 1 juv. sp. B.M. 196360W.

t. Aden, Feb., 1949 (Coll. Fraser-Brunner); 1 ♀, 5 juv. sp. B.M. 196361W.

u. Berbera, Brit. Somaliland, Feb., 1949 (Coll. Fraser-Brunner); 2 ♂. B.M. 196362W.

v. Muscat, Arabia (Townsend); 1 juv. sp. B.M.196363W.

w. Mersa Fijab (Manihine Coll.); 24.xii.1950; 1 ♂. B.M. 196364W.

x. Trincomali, 25.xi.1928; B.M. 1952.11.21.27. (det. Winckworth as *Sepia singalensis*); 1 shell.

y. Madras, 6.vi.1924; B.M. 1952.11.24.4–5. (det. Winckworth as *Sepia rouxi* and *singalensis*); 2 shells.

z. Mannar, 30.xii.1924; B.M. 1952.11.24.7. (det. Winckworth as *Sepia singalensis*); 1 shell (♀).

aa. Ennûr, 10.ii.1925; B.M. 1952.11.24.8. (det. Winckworth as *Sepia singalensis*); 1 shell (♀).

bb. Pari, 22.iv.1929; B.M. 1952.11.24.38; 1 shell.

cc. Madras, June, 1936; B.M. 1952.11.24.86–87. (det. Winckworth as *Sepia rouxii*); 2 shells (♀ ♀).

dd. Madras, July, 1936; B.M. 1952.11.24.90–91. (det. Winckworth as *Sepia singalensis*); 2 shells (♂ ♂).

ee. Madras, Aug., 1936; B.M. 1952.11.24.127. (det. Winckworth as *Sepia rouxii*); 1 shell (♀).

ff. Madras; 12.i.1936; B.M. 1952.11.24.167–168. (det. Winckworth as *Sepia singalensis*); 2 shells (♀ ♀).

gg. Madras, July, 1936; B.M. 1952.12.30.31. (det. Winckworth as *Sepia singalensis*); 1 shell (♀).

hh. Cottesloe, Perth, W. Australia (Pres. B. C. Cotton); B.M. 1962260W; 1 shell. (det. Cotton as *Crumenasepia ursulae* Cotton).

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
t	♀	109	91	49	23	38	100	14	40
j	♀	100	86	43	25	41	95	12	37
n	♂	82	92	44	24	37	94	13·5	37
m	♂	80	84	54	19	41	94	6·2	38
q	♀	41	90	52	24	46	100	14·5	34
w	♂	41	85	52	24	44	93	17	37

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
t	♀	109	38	41	49	138	27·5	1·56	2·75
j	♀	100	37	44	47	120	27	1·80	2·50
n	♂	82	37	37	46	104	24·5	1·10	2·45
m	♂	80	33	35	48	162	31	1·25	2·50
q	♀	41	34	34	39	61	22	1·46	2·45
w	♂	41	37	37	46	122	23	1·22	1·95

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Ventral ledge	Observations
y	–	295	30	8·1	73	3·1	7·8	
l	–	253	32	7·9	71	2·0+	9·1	
y	–	248	32	8·5	71	3·2	9·7	
e	–	222	34	9·9	72	2·0	7·7	
ee	♀	208	36	8·7	77	–	11·0	
ff	♀	202	33	9·4	77	–	11·9	
i	–	190	32	10·0	63	2·6	7·9	
z	♀	184	36	8·1	73	–	12·5	
f	♀	182	35	8·2	73	–	11·5	
hh	♀	168+	±37	±10	±75	±4·4	±10·6	pl. 8, figs. 42 & 43
gg	♀	168	35	9·2	68	–	12·5	
aa	♀	153	35	9·2	65	2·6	10·5	pl. 8, figs. 40 & 41
x	? ♂	150	33	9·3	64	3·0	10·0	pl. 8, figs. 38 & 39
cc	♀	145	34	8·6	72	2·1	8·9	
cc	♀	143	34	9·1	69	2·1	9·8	
ff	♀	133	35	9·4	71	–	11·2	
u	♂	133	33	7·9	72	–	9·0	
dd	♂	130	34	9·2	65	1·9	10·8	
dd	♂	125	33	9·6	64	1·6	12·0	
t	♀	109	33	9·2	59	3·7	8·3	
j	♀	101	36	10·9	57	–	9·9	
m	♂	80	36	10·0	55	–	8·8	
n	♂	79	32	7·6	67	3·8	8·9	
c	–	73	34	8·6	62	2·7	4·8	
t	–	58	36	8·6	53	3·4	11·2	
bb	–	58	35	7·8	60	4·3	8·6	
t	–	52	38	8·3	56	4·8	7·7	
q	♀	41	41	8·3	61	3·7	7·3	
w	♂	41	35	6·1	61	3·6	2·4	
s	juv.	40	35	8·2	65	–	5·0	
k	juv.	29	43	7·9	62	3·4	3·4	
q	–	16·5	48	–	60	3·0	–	

DESCRIPTION: Most of the animals are in rather poor condition, except those from the John Murray expedition (*m* and *n*).

In these two young males the dorsal arms are laterally compressed and the other ones strongly-keeled on their outer sides. The arm-suckers are irregularly denticulate on their distal margins, with well-developed papillate zones and radially-grooved outer areas which are slightly emarginate distally.

The buccal membrane is provided with a small sucker on some of its tips.

The tentacular stem is triangular in cross-section. The long club has a rather narrow swimming-membrane which extends slightly beyond the base of the club. The protective membranes are narrow and separated at the base of the club where the suckers are small and rather numerous. In the middle part of the club the suckers are arranged in very oblique, transverse series of eight, the third and the fourth sucker being much larger than the other ones (pl. 41, fig. 240).

In the smaller of these two males, the hectocotylus is not yet formed; in the larger one the left ventral arm bears about 12 transverse series of normal suckers proximally, followed by about 10 series in which the ventral suckers are of normal size but the dorsal ones are minute and separated from the ventral ones by a fleshy, transversely-grooved ridge.

At the base of the fins there is a series of elongate papillae, whereas the rest of the dorsal surface is covered by numerous small papillae.

The shell is elongate-oval; its dorsal side has three longitudinal ribs, it is granulous in surface texture and has rather broad chitinous margins.

The ventral surface has a wide shallow groove in the middle of the striated zone, the last loculus being very faintly grooved. On both sides of the striated zone there is a narrow, smooth area along the middle of which extend the narrow, rounded limbs of the inner cone. In its posterior part, the latter forms a long ventral ledge which is convex posteriorly but flat or even slightly concave in its anterior part.

The spine is devoid of keels but possesses two thick, lateral expansions at its base.

REMARKS: Adam (1939*c*, p. 60) has discussed the relationship between the different species enumerated in the synonymy of *Sepia pharaonis* and we have added *Sepia venustoides* Hoyle (=S. *venusta* Pfeffer *non* Münster) with some doubt. This species was based on a small specimen (mantle-length: 35·5 mm) from Zanzibar. Its tentacular club has eight, longitudinal series of suckers, with about five particularly big suckers in the middle. The shell does not seem to differ from that of a young *Sepia pharaonis*.

According to Iredale (1954, p. 77): "Adam has lumped all the species of *Crumenasepia* under the name *rouxii*, given to a bone from Bombay, India, supposing a range from Somaliland to Japan, although differences have been recorded in the animals from various localities and names proposed by efficient students."

Unfortunately, Iredale (1926*a*, p. 239) did not mention any differences between his *Crumenasepia hulliana* and other species; he only states (p. 240): "This represents a well marked group of which two or three species have been described as *Sepia singalensis* Goodrich from Ceylon, *S. koettlitzi* Hoyle & Standen from Somaliland and probably *S. zanzibarica* Pfeffer from Zanzibar." It is astonishing that he adds this last species, the shell of which has a completely different inner cone, like that of *Sepia aculeata*. His description does not give any character which permits us to distinguish his species from *Sepia pharaonis*.

Sepia pharaonis, as we understand it, seems in fact to have a very wide distribution, but certain species are widely distributed and we do not see the necessity to separate species only on the basis of their geographical distribution. In this respect it is noteworthy that Iredale never described the animal of even one of his numerous new species; they were all described on the cuttlebones, which

may float for a very long time and over very long distances, so that we are not even sure that these species really live on the coasts of Australia.

As to the differences which, according to Iredale, have been recorded in the animals from various localities, he does not mention any. There exist of course minor differences not only between animals from different localities but even from the same locality, but these may be attributed to individual variation, to age or to sex.

As Adam (1939*c*, p. 60–66) has discussed in detail the differences between these species and the reasons why we cannot distinguish them specifically, we refer to his paper.

We are indebted to Miss Virginia Orr (Philadelphia) who kindly lent us the specimen from Manila market which Voss (1962, p. 3) called *Sepia sinope*, but which is a young *S. pharaonis*.

13. ***Sepia prashadi*** Winckworth, 1936
(Pl. 9, figs. 44–48; pl. 41, figs. 245 & 246)

Sepia prashadi Winckworth, 1936, p. 16; Viader, 1937, p. 1; Adam, 1939*c*, p. 86, tabl. V; 1941, p. 109, pl. II, fig. 3; 1941*a*, p. 1; 1942, p. 10; 1944, p. 237; 1959, p. 134, figs. 3 & 4, pl. IV, figs. 1 & 2, pl. V.

TYPE LOCALITY: Madras.

GEOGRAPHICAL DISTRIBUTION: Mauritius (Viader, 1937); Madagascar (Adam, 1941); Gulf of Suez (Adam, 1959).

MATERIAL:

a. Madras, 1.iv.1930; B.M. 1952.11.24.59; 1 shell (holotype).

b. John Murray Exp. Sta. 75, Gulf of Oman, 25°10′48″N., 56°47′30″E., 28.xi.1933, 201 m., gn. m.; 7 ♂, 4 ♀. B.M. 196365—68 W.

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
b	♂	120	89	48	25	37	83	6·7	42
	♂	117	83	45	26	37	77	9·4	44
	♂	88	81	42	28	42	–	8·0	43
	♂	69	83	–	25	45	–	–	41
	♀	120	86	49	29	36	79	8·3	38
	♀	106	84	49	25	38	80	–	35
	♀	81	84	–	26	37	–	–	39

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
b	♂	120	42	43	42	–	–	1·84	–
	♂	117	41	44	39	–	–	1·71	–
	♂	88	39	39	40	91	18	1·94	5·7
	♂	69	41	41	43	138	22	1·74	6·1
	♀	120	36	38	42	–	–	1·67	–
	♀	106	35	38	38	–	–	1·88	–
	♀	81	39	39	39	105	17·5	1·60	5·6

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
b	♀	120	30	10·6	58	4·6	pl. 9, figs. 46–48
	♂	88	31	10·8	53	5·7	pl. 9, figs. 44 & 45
	♀	81	32	9·8	54	6·2	
	♂	69	33	10·2	57	4·3	
a	–	84	30	8·3	68	3·0	Holotype

DESCRIPTION: Although the shells of this species have been reported from different localities outside the Red Sea, the animals have only been described from the Gulf of Suez (Adam, 1959, p. 134). The study of the additional specimens from the Gulf of Oman gives us the opportunity to complete this description.

The fins begin several millimetres distance from the mantle-margin and do not seem to be very large, but most of the specimens are rather contracted. At the posterior end the fins are distinctly separated.

The arms are sub-equal, the dorsal ones are slightly keeled at the distal end of their outer sides, the dorso-lateral and ventro-lateral ones are more strongly keeled along their whole ventral margins, and the ventral ones have strong swimming-membranes on their outer sides. All the arms have narrow protective membranes.

The suckers are more or less globular in the male and are quadriserial throughout the whole length of the arm. In the greater proximal part the outer suckers are smaller than the inner ones; but on the distal effilated tips, the outer ones are slightly wider than the inner ones, except on the ventral arms.

The hectocotylus has two groups of four suckers at its base. The transformed portion of this arm occupies the greater part of the length; it is broadened, especially in the middle, flattened and with transverse folds. The suckers are very small, the two ventral rows being very close together, forming practically a single series. The dorsal suckers of the hectocotylized part are larger than the ventral ones. In the basal half of the transformed portion, the two dorsal series are wide apart, one in the middle, the other at the dorsal margin. In the distal part, these series come closer and closer together. The distal tip of this arm has four series of minute normal suckers. There are 12 to 14 transverse rows of four suckers on the hectocotylized portion.

The tentacular stem is rounded. The club is short and broad, with a strong swimming-membrane on the dorsal side, its length slightly exceeding that of the club. The sucker-bearing part of the club is nearly completely detached from the tentacle by a deep furrow underneath the dorsal protective membrane (pl. 41, figs. 245 & 246). Both protective membranes are well developed; they come close together at the base of the club, but remain separate and do not seem to continue down the stem.

The tentacular suckers appear to be arranged in very oblique transverse series of eight, but owing to the enormous development of the third sucker from the second to the fourth series, especially from the second and third one, all the other, smaller, suckers are pushed aside.

In the female, the suckers of the sessile arms are less globular than in the male. The tentacular club does not show any difference. The ventral part of the buccal membrane is not expanded ventrally.

The shell is elongate with three ribs on its dorsal surface; the latter is strongly rugose, especially in the anterior part and on the lateral margins of the posterior end. The shell is rather thick with a narrow, median furrow over the whole length of its ventral surface; this groove widens at the anterior end of the last loculus. The striated zone is mostly convex, except in its posterior portion, and shows two broad ribs separating the ventral part from the lateral areas.

There are two narrow smooth areas between the striated zone and the outer cone.

The limbs of the inner cone lie approximately in the middle of each smooth area. In the posterior half of the striated zone, the limbs of the inner cone are widened and fused with the outer cone. Only the posterior end of the inner cone is raised in a thick ledge which surrounds the posterior pit. The rather narrow outer cone completely surrounds the inner cone. The spine is strong, straight, directed slightly upwards; it has a strong ventral and a less well-developed dorsal keel.

Remarks: In all the specimens from the Gulf of Oman, the big suckers on the tentacular club are much more developed than in those from the Gulf of Suez (Adam, 1959, pl. IV, fig. 2). For the moment we do not know if this character has any sub-specific significance. It may be only a variable character because two female specimens (M.L.d. = 79 and 78 mm) and a male specimen (M.L.d. = 91 mm) from the southern Red Sea (belonging to the Department of Zoology of the Hebrew University of Jerusalem), also have enormous tentacular suckers, the indices being 5·7, 6·0 and 5·2%.

14. ***Sepia recurvirostra*** Steenstrup, 1875
(Pl. 9, figs. 49–52; pl. 10, figs. 53 & 54)

Sepia recurvirostra Steenstrup, 1875, p. 475, 479; Tryon, 1879, p. 197; Hoyle, 1886, pp. 23, 137, 205, 218; Adam, 1939*c*, p. 88; Voss, 1963, p. 36; Adam, 1965, p. 169, pl. 29, figs. 1–3.
Sepia singaporensis Pfeffer, 1884, p. 10, figs. 13 & 13*a*; Hoyle, 1886*a*, p. 231; 1886, p. 128; Goodrich, 1896, p. 3; Massy, 1916, p. 225; Robson, 1932, p. 29; Adam, 1939*c*, p. 81, pl. III, fig. 3.
? *Sepia pagenstecheri* Pfeffer, 1884, p. 9, figs. 12 & 12*a*; Adam, 1939*c*, p. 84.
Sepia esculenta, Joubin, 1897, p. 102 (*non* Hoyle, 1885); ?Massy, 1916, p. 225.

Type localities: South China (*S. recurvirostra*); Singapore (*S. singaporensis*); Hong Kong (*S. pagenstecheri*).
Geographical distribution: Singapore; Burma; Borneo Bank; Java Sea.[1]
Material:

a. ? N. China (Purchased Jamrach); B.M. 1863.5.1.6; 1 ♂ (macerated).
b. Santubong and Buntal, Sarawak (Coll. E. Bartlett); B.M. 1894.7.14.6; 1 shell.
c. Singapore fish market (Pres. Director, Raffles Museum); B.M. 1947.5.16.2. (det. Robson); 1 ♂.
d. Singapore, May, 1933 (Coll. Winckworth); B.M. 1952.11.24.93; 1 shell (this shell probably belonged to a male specimen presented by Winckworth to the Royal Institute of Natural Sciences in Brussels).

Measurements:

Animal (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
c	♂	60	90	50	28	42	93	–	45

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
c	♂	60	45	50	45	–	–	1·7	–

[1] The exact locality is 6° 36′, 5 S., 114° 55′, 5 E.; as a result of a printing error it was given as 144° 55′5 E. by Adam, 1939*c*, p. 82.

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
a	♂	71	32	9·3	62	2·8	pl. 10, figs. 53 & 54
c	♂	60	30	7·8	65	3·3	pl. 9, figs. 49 & 50
b	–	55	35·5	8·6	65	2·7	
d	? ♂	45	32	7·1	62	4·4	pl. 9, figs. 51 & 52

DESCRIPTION: The animal from N. China (*a*) is macerated. The right ventro-lateral tip of the buccal membrane is longer and thicker than the other ones and bears a minute sucker.

The shell of this specimen (pl. 10, figs. 53 & 54) differs from the other ones in that the anterior part of the striated area is broader and a little more convex and also in the slightly narrower limbs of the inner cone. The locality and the identity of this specimen remain somewhat doubtful until more material becomes available.

The animal from Singapore (*c*) has arms with narrow tips and has quadriserial suckers nearly to the tip. The arm-suckers have their chitinous rings each armed with about 15 bluntly-sharp teeth in their distal part. The hectocotylus has four or five rows of normal suckers at the base, followed by about six rows of smaller suckers, the rest of the arm being normal. On the short, modified portion of the hectocotylus the ventral suckers are slightly larger than the dorsal ones. The buccal membrane is devoid of suckers.

The tentacular club has been described by Pfeffer (1884, p. 10) and by Adam (1939*c*, p. 82); its suckers are arranged in five or six longitudinal series, the middle one of them possessing five or six large suckers. The swimming-membrane extends for a short distance beyond the base of the club; the protective membranes are fused at the base. In the male type specimen of *S. singaporensis* the distal ends of its dorsal arms are very narrow and provided with only two series of suckers, while the tips are devoid of suckers.

The shell is elongate oval and regularly acuminate in its anterior half. The dorsal surface has a low, narrow, median rib and is covered with delicate granules, arranged along the growth-lines; the chitinous margins are narrow and the extreme posterior portion is smooth and shiny. The ventral surface is flattened with a very narrow median furrow in the striated area and a broader depression in the last loculus; the striae are regularly convex. The striated area is separated from the outer cone by two, nearly smooth, slightly-concave marginal zones. The lateral limbs of the inner cone are attached to the margins of the striated area; they are rather broad in their posterior part and are fused to the outer cone. Only the extreme posterior portion is raised as a thin ledge and connected with the outer cone by a dark-coloured thick callous substance which is emarginate in front. The spine is short, turned upwards and without any keel.

REMARKS: On p. 39 we discuss the differences between *S. recurvirostra* and *S. papuensis* and on p. 44 those between *S. recurvirostra* and *S. plangon*.

After having examined the type-specimens, Adam (1939*c*, p. 84–85) came to the conclusion that *S. pagenstecheri* Pfeffer, 1884, from Hong Kong, does not seem to differ in any important character from *S. recurvirostra*, but that more material should be studied before taking a definite decision.[1]

[1] Since this manuscript was set up in type, Adam (1965, p. 169) has examined the type specimens of *S. recurvirostra* Steenstrup from the Copenhagen Museum; these prove to be conspecific with *S. singaporensis*, the former name having priority.

15. ***Sepia officinalis vermiculata*** Quoy & Gaimard, 1832
(Pl. 10, figs. 55 & 56; pl. 45, fig. 271)

Sepia vermiculata Quoy & Gaimard, 1832, p. 64, pl. I, figs. 1–5; Férussac & d'Orbigny, 1835–1848, p. 279, pl. 3 *bis*; Smith, 1916, p. 20; Robson, 1924, p. 12; Massy, 1925, p. 209; 1928, p. 91.
Acanthosepion vermiculatum, Rochebrune, 1884, p. 113; Adam, 1944, p. 234.
Acanthosepion vermiculata, Robson, 1924*a*, p. 639; Massy, 1927, p. 156.
? *Sepia hierredda* Turton, 1932, p. 2 (? *non* Rang).
? *Sepia jousseaumi* Rochebrune, 1884, p. 117; Smith, 1916, p. 22; Adam, 1941, p. 108, pl. IV, fig. 3; 1944, p. 235.
Sepia officinalis vermiculata, Adam, 1941, pp. 99, 102, 106, pl. IV, fig. 1; 1962, p. 11; Voss, 1962*b*, p. 249.

TYPE LOCALITIES: Cape of Good Hope (*S. vermiculata* and *S. jousseaumi*).

GEOGRAPHICAL DISTRIBUTION: South Africa.[1]

MATERIAL:

a. Port Natal (Purchased Ayres); B.M. 1862.12.19.7; 1 ♂.
b. S. Africa (Ponsonby); B.M. 1890.5.20.55; 1 shell.
c. Port Elizabeth (Spencer); B.M. 1890.12.14.35–38; 4 shells (damaged).
d. Natal (Mar. Biol. Surv., Gilchrist, Sta. 386); B.M. 1924.9.9.41–42; 1 ♂ (det. Robson).
e. Delagoa Bay, Oct., 1912 (Coll. Barnard, No. 1317*a*); B.M. 1926.10.20.41; 1 ♀ (M.L.d. = 128 mm).
f. Delagoa Bay, Oct., 1912 (Coll. Barnard, No. 1317*d*); B.M. 1926.10.20.42. (animal) and 1926.10.20.44 (shell); 1 ♂ (M.L.d. = 68 mm).
g. Knysna Estuary (Univ. Cape Town, Ecol. Surv., KNY. 8B, 15.vii.1947, J. H. Day); 1 ♀. B.M. 196369W.
h. Knysna Estuary, dredged in main channel between Leisure Isle and Theseus Wharf, 2–6 m (Univ. Cape Town, Ecol. Surv., KNY, 8B., 15.vii.1947, J. H. Day); 1 ♀.
i. Univ. Cape Town, Ecol. Surv., DBN. 15 R., 10.vii.1950, J. H. Day; 3 ♀ (M.L.d. = 105, 70 and 47 mm); B.M.196370W.
j. Idem, BMR. 13 A, 10.ix.1950, J. H. Day; 2 ♀ (M.L.d. = 96 and 68 mm); B.M. 196371W.
k. Idem, BMR. 27 A, 15.ix.1950, J. H. Day; 2 ♀ (M.L.d. = 61 and 59 mm); B.M. 196372W.
l. Isipingo (Falcon); B.M. 1952.11.24.80; 1 shell.
m. Isipingo (Falcon); B.M. 1952.12.30.74; 1 shell.

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L I
d	♂	148	78	49	26	41	100	15	44
g	♀	120	85	54	33	42	98	13·5	33

Loc.	Sex	M.L.d. in mm	A.L. II.	A.L. III.	A.L. IV.	T.L.	T.cl.	S.a.	S.t.
d	♂	148	47	54	57	–	34	1·7	5·4
g	♀	120	33	33	46	150	32	1·7	3·3

[1] According to Barnard (*in litt.*) it occurs as far north as Chinde, mouth of the Zambesi River.

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
d	♂	148	40	13	51	3·4	
g	♀	117	39	12	51	3·0	
j	♀	68	40	12	53	4·4	
k	♀	60	40	12·5	50	3·3	
k	♀	55	44	13·5	53	–	
l	–	115	41	10·5	50	–	pl. 10, figs. 55 & 56
m	–	93	41	11	40	5·4	

DESCRIPTION: Most of the animals are in poor condition. The male specimen from Natal (*d*) has zebra-like stripes on the dorsal mantle surface. The dorsal margin protrudes in a bluntly-rounded right angle, reaching to the mid-level of the eyes. All the arms are keeled on the outer sides. The arm-suckers usually have smooth chitinous rings, but those of the distal ones are finely incised.

The left ventral arm is hectocotylized on a little less than half of its length. At the base there are two groups of three and one row of four normal suckers, followed by about 12 transverse rows of smaller ones, situated on the ridges of the flat transformed portion. The two, ventral, longitudinal series are close together, near the ventral margin, the third series is about in the middle of the arm and much smaller than the other ones, while the dorsal series shows the suckers of about the same size as the ventral ones, it is situated between the third series and the dorsal margin.

The tentacular club has a broad swimming-membrane which is slightly shorter than the club. The narrow, protective membranes remain separated at the base of the club and continue down the stem as low membraneous ridges.

The tentacular suckers are apparently arranged in five or six series but form, in fact, oblique transverse rows of eight (pl. 45, fig. 271). Six or seven suckers of the third longitudinal series are much larger, those of the second series are half as wide, those of the first and fourth series half as wide as those from the second one. The big suckers have smooth chitinous rings, the smaller ones show numerous fine denticles.

The shell is broadly oval (pl. 10, figs. 55 & 56); its dorsal surface is coarsely granulous with a faint median rib, and its posterior portion is covered by a glaze-like substance. The ventral surface is rather convex with a median rib. The striae are regularly convex except in the middle where they are slightly concave on the median rib. The inner cone is rather large; it is completely fused to the outer cone and surrounds a small depression. The outer cone is broad and continuous behind the inner cone. The rounded spine is nearly straight, directed slightly towards the ventral side.

The figured shell from Isipingo (pl. 10, figs. 55 & 56) is flatter than the other ones; its striae are more wavy.

REMARKS: This sub-species is certainly very closely related to *Sepia officinalis hierredda* Rang from the West African coast. The animals do not show any noteworthy difference as regards their relative measurements, their tentacular clubs and their hectocotyli. The specimens hitherto described show an enormous difference in maximum size: *S. officinalis hierredda* attaining a mantle-length of 360 mm in the males and 280 mm in the females (Adam, 1941 and 1952), whereas in *S. officinalis vermiculata* the males measure up to 148 mm, the females up to 147 mm (Adam, 1962). But the fact that no bigger animals are present in the collections does not prove that they do not exist.

The shells of the two races seem to be slightly different, those of *vermiculata* being somewhat wider and thicker, as shown by the following comparative table of the relative measurements.

Sub-species	Sex	Number	L. in mm	W.	Th.	Str.z.	References
hierredda	♂	20	52–360	30–37	9·8–13	42·5–65	Adam, 1941 and 1952
vermiculata	♂	4	91–148	36–40	11·3–13·1	40–55	Adam, 1941, 1962 and present paper.
hierredda	♀	35	40–280	33–41	7·0–12·5	37·5–72	Adam, 1941 and 1952
vermiculata	♀	6	55–147	39–44	9·5–13·5	47–64	Adam, 1941, 1962 and present paper.

Moreover, the posterior part of the shell seems to be more broadly rounded and the dorsal surface more coarsely granulous in *vermiculata.*

Sepia officinalis hierredda (pl. 11, figs. 57–60) is a very common littoral cephalopod of the West African coast where it has been reported, until now, between 21° N. and 16°30′ S., in 0–100 m depth. Further collecting between Angola and South Africa may extend the southern limit of its distribution further south and more collecting of *Sepia officinalis vermiculata* in South Africa may prove that the small differences mentioned between the two sub-species are not sufficient to separate them. But for the moment we think it advisable to keep them separate.

At its northern limit, *Sepia officinalis hierredda* meets *Sepia officinalis officinalis* Linné, 1758, in Levrier Bay (Mauritania), where Adam (1941, p. 98) found intermediate forms between the two, which seems to prove that they are both sub-species of *Sepia officinalis.* The nominate sub-species extends from Levrier Bay up to the Atlantic coast of France and probably into the Mediterranean. A fourth sub-species: *Sepia officinalis filliouxi* Lafont, 1868, even reaches the southern coast of Scandinavia. A fifth sub-species, *Sepia officinalis mediterranea* Ninni, 1884, lives in the Mediterranean (Adam, unpublished observations).

As very few authors have described the material they mention of *Sepia officinalis*, it is for the moment impossible to give an exact review of the European sub-species and of their distribution (see Adam, 1941).

It is noteworthy that the young animals of the different sub-species cannot be distinguished.

16. ***Sepia vicellius*** Gray, 1849

Sepia vicellius Gray, 1849, p. 100; Adam, 1959, p. 151.
? *Sepia vicellus*, Rochebrune, 1884, p. 116; Adam, 1942, p. 3; 1944, p. 235.

TYPE LOCALITY: unknown.
GEOGRAPHICAL DISTRIBUTION: ? Red Sea (Rochebrune).
MATERIAL:

a. Locality unknown, Gray No. 29 *a*, *b*; 1 ♂ (holotype). B.M. 1963120W.

DESCRIPTION: The animal is in a rather macerated condition and the shell is badly damaged, its posterior portion being completely destroyed.

The tentacular club, the hectocotylus and the remaining part of the shell do not leave any doubt that this specimen belongs to *Sepia officinalis.*

REMARKS: As Adam (1944, p. 235, 1959, p. 151) pointed out, the specimen from the Red Sea mentioned by Rochebrune (1884, p. 116), is poorly preserved, with its shell lacking.

As Gray's specimen belongs to *Sepia officinalis*, a species which has never been found in the Red Sea, we suppose that Rochebrune's specimen was some other form.

17. ***Sepia latimanus*** Quoy & Gaimard, 1832
(Pl. 11, figs. 61–63; pl. 45, figs. 269A)

Sepia latimanus Quoy & Gaimard, 1832, p. 68, pl. 2; Férussac & d'Orbigny, 1848, p. 283, pls. 12, 17; Whitelegge, 1889, p. 282; ? Brazier, 1892, p. 11; ? Meyer, 1909, p. 331; Chapman, 1912, p. 25; Wülker, 1913, p. 455; Robson, 1932, p. 31; Adam, 1939*c*, p. 41, pl. I, figs. 1–3; Voss, 1963, p. 26, pl. I, figs. *d–e* & text-fig. 2*d* & 3*b*.
Sepia rappiana Férussac, 1835, pl. 10; Adam, 1939*c*, p. 47.
Acanthosepion rappianum, Rochebrune, 1884, p. 105; Adam, 1944, p. 232.
Sepia hercules Pilsbry, 1894, p. 144; 1895, p. 2, pl. I, figs. 1 & 2; Sasaki, 1929, p. 177, figs. 168 & 169; Adam, 1939*c*, p. 48.
Ponderisepia eclogaria Iredale, 1926*a*, p. 239, pl. XXXV, figs. 7 & 8; 1954, p. 78.
Sepia eclogaria, Adam, 1939*c*, p. 49.
Sepia harmeri Robson, 1928, p. 8, figs. 2 & 3; Adam, 1939*c*, p. 49.
Sepia mozambica Rochebrune, 1884, p. 118; Adam, 1939*c*, p. 50; 1944, p. 235.

TYPE LOCALITIES: Port Dorey (*S. latimanus*); Kangaroo Island (*S. rappiana*); Loo Choo Islands (*S. hercules*); Masthead Island (*P. eclogaria*); Poulo-Condor (*S. harmeri*); Mozambique (*S. mozambica*).

GEOGRAPHICAL DISTRIBUTION: Indo-Pacific, from Australia to Japan and from Malaya to Fiji Islands.

MATERIAL:

a. Sarawak, Borneo; B.M. 1894.7.14.2; 1 shell.
b. Singapore, fish market (Pres. Director, Raffles Museum, Singapore); 1947. 5.16.1; 1 ♀.
c. Phare's Island, lagoon of Noumea, New Caledonia, May, 1961 (Pres. Bidder); 1 shell. B.M. 196373W.

MEASUREMENTS:

ANIMAL (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
b	♀	265	85	45	40	38	89	15	40

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
b	♀	265	49	43	53	130	27	1·5	3·4

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex.	L. in mm	W.	Th.	Str. z.	Spine	Observations
a	—	330	36	±9·7	±67	4	
b	♀	260	36	10	65	—	pl. 11, figs. 61 & 62

DESCRIPTION: The right ventral arm is bifid at the tip in the animal from Singapore (pl. 11, fig. 63); there is a dorsal branch of 22 mm and a ventral one of 14 mm, both bearing four rows of suckers and the number of suckers is doubled before the bifurcation of the arm.

The web is a little less developed than in *S. apama*, reaching about halfway along the length of the arms, except between the ventral arms where it is absent.

The three tubercles seen behind each eye in *S. apama* are lacking.

The tentacular club strongly resembles that of *S. apama*, in the sucker-bearing surface being completely surrounded by the protective membranes which are fused at the base, and in the deep groove

between the swimming-membrane and the dorsal protective membrane, detaching the sucker-bearing surface nearly completely from the stem (pl. 45, fig. 269A). The swimming-membrane extends only slightly beyond the base of the club; in *S. apama* it is longer.

The shell shows a very faint indication of three dorsal ribs, but this surface is almost regularly convex, much more so than in *S. apama*, and is strongly rugose on the whole surface, except on the narrow chitinous margins. The ventral surface has a distinct median groove, the striae being strongly reversed V-shaped in the anterior portion of the striated area. The inner cone is completely fused to the outer cone, its outer margin forming a distinct, flat, shiny, zone which is slightly raised in its posterior part; a similar formation is seen in the shell of *Sepia savignyi*, which differs from that of *S. latimanus* in the slightly-broader inner cone and the less-rounded, more acuminate anterior end. The outer cone is continuous behind the inner cone as a very narrow chitinous margin. The spine is strong and straight, without any keels and with a ventral notch at its base.

REMARKS: Adam (1939*c*, pp. 45–51) has already discussed in detail the different species given above as synonyms of *Sepia latimanus*. Concerning *Ponderisepia eclogaria*, Iredale (1954, p. 78) states that the shell of his species does not agree with the description of *latimanus* and "it is a smaller shell, with minor differences, than *hercules*, a Japanese species".

Unfortunately, Iredale does not give any reasons why his species does not agree with the description of *S. latimanus* or of *S. hercules*. Sasaki (1929, p. 179) was "greatly inclined to consider the species (*S. hercules*) to be identical with *Sepia latimanus*". Neither the description, nor the figures of *P. eclogaria* permit us to distinguish this species from *S. latimanus*.

According to Iredale (1954, p. 71) "the large Shark's Bay species was recorded by Meyer, without consideration, as *latimanus*, described from Dorey, west New Guinea, and this turns out to be very different, as was anticipated". Iredale does not mention if his opinion was based on a study of Meyer's material, for which he proposes a new name *Amplisepia parysatis* (see p. 38).

After having examined the specimens recorded by Chapman (1912, p. 11) from Torquay, Victoria, Iredale (1954, p. 70) states that "the 'plesiotype' of *latimanus* proves it to be a *Mesembrisepia* as above noted, the measurements, 139 by 47 mm, coming close again to *macandrewi*".

18. ***Sepia apama*** Gray, 1849
(Pl. 12, figs. 64–67; pl. 45, fig. 269)

Sepia apama Gray, 1849, p. 103; Tryon, 1879, p. 194; McCoy, 1888, pls. 188–190; Whitelegge, 1889, p. 282; Brazier, 1892, p. 11; Chapman, 1912, p. 23, pl. I; Suter, 1913, p. 1058, pls. 67, 68 & 69, fig. 1*a*; Hedley, 1918, p. M.33; Adam, 1939*c*, p. 51; Macpherson & Chapple, 1951, p. 156.

Lophosepion apama, Rochebrune, 1884, p. 92; Adam, 1944, p. 225.

? *Amplisepia verreauxi* Iredale, 1926, p. 194, pl. XXIII, figs. 1 & 2; 1954, p. 70; Iredale & McMichael, 1962, p. 98 (*non* Rochebrune, 1884).

Amplisepia apama, Iredale, 1926, p. 194; 1954, p. 70; Verco & Cotton, 1928, p. 127; Cotton, 1929, p. 90; 1931, p. 40, fig. 2; Hope MacPherson & Gabriel, 1962, p. 408.

Sepia (*Amplisepia*) *apama*, Cotton & Godfrey, 1940, p. 431, figs. 419 & 420.

? *Sepia palmata* Owen, 1881, p. 134, pls. XXIV & XXV; Brazier, 1892, p. 13; Adam, 1939*c*, p. 52.

? *Amplisepia palmata*, Iredale, 1954, p. 71.

? *Amplisepia parysatis* Iredale, 1954, p. 71, pl. IV, figs. 1 & 2.

Sepia sp. b. Voss, 1962, p. 3.

TYPE LOCALITIES: Port Adelaide (*S. apama*); Sydney (*A. verreauxi* Iredale); Norfolk Island (*S. palmata*); Shark's Bay (*A. parysatis*).

GEOGRAPHICAL DISTRIBUTION: Australia; ? New Zealand.

MATERIAL:

a. Port Adelaide, S. Australia; B.M. 1846.5.25.2.; 1 shell (holotype).
b. Hobson's Bay, Melbourne (McCoy); B.M. 1886.2.27.1; 1 shell.
c. Cobblers beach, Middle Harbour, Port Jackson (Coll. Brazier); B.M. 1890.6.21.1; 1 ♀.
d. Adelaide, 1953 (Coll. Kaspiew); Royal Institute of Natural Sciences, Brussels; 1 ♂, 3 shells.
e. Semaphore, S. Australia (Pres. Cotton); B.M. 1962259W; 2 shells.

MEASUREMENTS:

ANIMAL (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex.	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
c	♀	300	78	48	42	42	100	13	45

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
c.	♀	300	52	53	58	135	25	1·5	3·3

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L.in mm	W.	Th.	Str.z.	Spine	Observations
a	—	285	35	±10·5	±53	—	
c	♀	300	36	±10	58	—	pl. 12, figs. 64 & 65
d	♂	243	35·5	10	58	—	
	—	230	36·5	± 9	±65	—	
	—	210	39·5	± 8	±65	—	
	—	110	43·5	—	—	—	
e	—	215	37·5	10	61	—	
	—	97	45·5	9·3	53	2	pl. 12, figs. 66 & 67

DESCRIPTION: The shell has a long conical shape, being bluntly-rounded at its anterior margin and gradually acuminate at the posterior end. The dorsal surface shows a faint indication of three ribs in its posterior part, its anterior half is flatly convex; the posterior half is reticulate granulous, especially on the lateral portions. The anterior part is less granulous, being nearly smooth. Near the posterior end there is a slight indication of a spine which is completely hidden by the granulous covering. The ventral surface is rather convex in the anterior third; the striated area shows regularly convex striae and a shallow median groove which is more distinct near the posterior margin of the last loculus where the surface is convex on both sides of the groove. The inner cone consists of two portions: an inner one with narrow limbs and with a short narrow-angled V-shaped, posterior part of about 13 mm length and thick limbs limiting the posterior end of the striated area, and a much wider, completely flat portion with rather broad limbs, completely fused with the outer cone, and extending as a long bluntly-acuminate prolongation towards the posterior end. The outer cone is broad in the posterior third of the shell and completely surrounds the inner cone.

The shell of the female specimen (*c*) has broad chitinous margins in its anterior half (pl. 12, figs. 64 & 65). The ventral median groove is distinct for the whole length of the striated area which consists of two convex portions. The inner cone is finely granulous in its posterior, thickened, inner portion. The spine is still visible.

The body of this animal is broadly oval; the dorsal mantle-margin projects forward (broadly-convex) and the ventral margin is emarginate. The fins are very broad. Behind each eye there are three

flat, semicircular, membraneous papillae of about 5–7 mm width. The arms are more or less distorted in spirit, but all appear to be keeled on their outer sides. The web is very high, except between the ventral arms; between the dorsal arms it reaches about half the arm-length and between the lateral ones up to two-thirds. The arm-suckers are relatively small and quadriserial; the distal ones have the distal half of their chitinous rings dentate with numerous, close-set, narrow teeth. The tentacular club has a swimming-membrane which extends on the stem for about the same length as the club. The dorsal protective membrane is distinctly detached from the stem; united with the ventral protective membrane it forms a broadly-oval sucker-bearing surface which is completely separated from the stem and connected with the latter by a thin membrane (Pl. 45, fig. 269). The suckers appear to be arranged in five longitudinal series, those of the median series being largest. The left tentacle shows an abnormal phenomenon, there being two small suckers on the stem near the base of the club. The smaller tentacular suckers have their chitinous rings finely dentate all around.

The male specimen (*d*) belonging to the Royal Institute of Natural Sciences (Brussels) is in rather poor condition. Its ventral arms are long and very stout compared with the other ones. On the distal half of these arms the protective membranes, especially the dorsal ones, are very broad and are reinforced with thick, transverse, muscular ridges. The left ventral arm is hectocotylized and possesses about eight transverse rows of four suckers at its base, followed by about the same number of rows of smaller suckers; the distal half of the arm is normal. In the shell of this specimen the spine is still visible and is not completely covered by the calcareous surface of the posterior part.

In two other shells from this locality the spine is completely hidden. The smaller of these specimens differs from the other shells in its more regular general form, the posterior part of the outer cone being much broader. The extreme posterior portion of this shell behind the striated area, is much more strongly curved towards the ventral side. These three shells have broad, chitinous margins in the anterior part of the dorsal surface.

In the collections of the Royal Institute of Natural Sciences (Brussels) there is a rather puzzling shell from Adelaide (Coll. Kaspiew), measuring 110 × 48 mm, which resembles *S. apama* in its broadly-rounded, anterior portion and its strongly-acuminated posterior half. Its dorsal surface is weakly convex, nearly flat anteriorly, more and more rounded posteriorly, with a slight indication of three ribs. It is faintly granulous in its anterior part and reticulate granulous posteriorly. The ventral surface is very flat, but the specimen being rather worn it is not possible to measure its exact thickness. The striated area shows a very shallow, broad, median groove, the striae being regularly convex. The inner cone has rather narrow limbs and in the posterior part their outer margin is flatly rounded. The posterior part of the inner cone is not drawn out as in *S. apama*, but in the inner angle of the inner cone there is the same thick, V-shaped formation as in this species. The outer cone is rather narrow, and only slightly continuous behind the inner cone.

There is no trace of a spine, but the posterior end shows a small, smooth, rounded knob. As young shells of *S. apama* have never been thoroughly described or figured, we could not decide if this shell belongs to *S. apama*. But the small shell from Semaphore, presented and identified by Cotton does not leave any doubt (pl. 12, figs. 66–67).

Compared with adult shells, the young shell is much less acuminate behind and is provided with a distinct short spine. The anterior portion of this shell is exactly like the adult shell—flattened, even somewhat concave, delicately granular, with a few linear furrows. The posterior part of the dorsal surface is coarsely granular with a reticulate pattern. The greater part of the ventral surface does not differ from the adult shell, the anterior portion of the striated area being flattened with a weak indication of a narrow median furrow. The posterior part shows marked differences. The inner cone is narrower, completely fused to the outer cone, but distinctly limited, cream-coloured, with a flattened, shiny outer margin, well distinct from the inner part of the lateral limbs which are deli-

cately striated longitudinally. The white V-shaped callous formation in the inner angle of the inner cone is much less developed than in the adult shells. The outer cone is slightly broader than the limbs of the inner cone; its posterior portion, separating the inner cone from the spine, is very short and radially striated, whereas it is very long and acuminate in larger specimens. The spine is short, stout, and straight, without any keels.

Finally, we received for identification a small immature specimen (M.L.d. = 38 mm) from S. Australia, belonging to the Academy of Natural Sciences of Philadelphia (No. 72732) and mentioned by Voss (1962, p. 3) as "*Sepia* sp *b*". The animal does not differ in any apparent respect from that of *S. bandensis* and without having examined the shell we should not have hesitated to identify it with that species. The dorsal mantle-margin has exactly the same rounded form, the tentacular club is exactly similar, the swimming-membrane extending beyond the base of the club, the protective membranes being fused at the base and separating the sucker-bearing surface from the stem. The unequal suckers seem to be arranged in five longitudinal series, but as in *S. bandensis* they probably constitute oblique series of eight in the middle of the club. Those of the third series are largest, those of the second one are somewhat smaller and those of the fourth one intermediate in size between those of the first and second series; the remaining, ventral ones are much smaller. Their chitinous rings have the same dentition of numerous partly-fused, fine denticles, like those of the arm-suckers but are more numerous.

But, although the animal is very like, and cannot be separated from *S. bandensis*, the shell proves that this specimen is a young *S. apama*. The shell is broadly rounded at the anterior margin and is narrower towards the posterior end. The dorsal surface is rather convex in the middle and is much flatter anteriorly, but it has strongly-sloping, flattish sides in the posterior portion, the central part of which forms a strongly convex rib. The anterior flat portion does not show any ribs—only a few radiating linear grooves. The surface is finely granulous in the anterior part, more and more coarsely granulous towards the posterior end, the granules being first arranged along the growth lines but form a reticulate pattern at the posterior end.

The ventral surface is very flat, the striated area having a faint linear median groove, and the last loculus is broadly concave in the middle. The striae are convex towards the margins but nearly straight in the middle. A very narrow smooth zone separates the striated area on both sides from the outer cone. The inner cone is exactly the same as in *S. bandensis*, its lateral limbs are reflected and fused to the outer cone, its posterior part forming a narrow rounded rim around the posterior depression. The outer cone is continuous behind the inner cone as a narrow, radially-grooved ledge. A small spine is present, but rather worn.

At first view, this shell might be confused with that of *S. bandensis*, but the general form of the latter is more regularly oval, its whole dorsal surface convex and reticulate granulous, and there is no trace of a spine. The ventral surface is very similar, especially in the inner cone, but the outline of the striae is different and more regularly convex in *S. bandensis*.

The relative measurements of this immature shell of *S. apama* are: W = 49%, Th. = 10%, Str.z = 58%.

It is noteworthy that the inner cone does not show the inner thickened portion which is characteristic of larger shells.

Remarks: The tentacular club of *S. apama* presents a very strong resemblance to that of *S. latimanus* (see p. 34) but the shell is quite different.

Iredale (1926, p. 194) created a new genus *Amplisepia* for *S. apama* Gray "whose sepion differs entirely from that of the remainder of the Australian species yet known, save its eastern representative *A. verreauxi* Rochebrune". As Adam (1939*c*, p. 52; 1944, p. 229) pointed out and as we discuss on p. 47 of this report, Iredale was completely mistaken in describing Rochebrune's species, which is

synonymous with *Sepia mestus* Gray, as the eastern representative of *S. apama* Gray. In fact, Iredale (1926, p. 194, pl. XXIII, figs. 1 & 2) figured as *Amplisepia verreauxi* a shell which we are unable to distinguish from *S. apama*. According to Iredale (1926, p. 195) it "may be distinguished from the Adelaidean type by the narrower inner cone, the smaller phragmocone and the less prolonged mucronal area". In 1954 (p. 70) Iredale maintained his erroneous interpretation of *S. verreauxi* in stating that in *Amplisepia apama* "geographical variation can be seen, and the eastern form has been listed under the name *verreauxi*, but animals must be studied to substantiate the distinction". The animal from Port Jackson described above, does not substantiate this distinction.

As Adam (1939*c*, p. 53) pointed out, *Sepia palmata* Owen is probably identical with *S. apama*, but as Owen's material no longer exists, a conclusion cannot be drawn.

Finally, Iredale, (1954, p. 71, pl. IV, figs. 1 & 2) described a new species *Amplisepia parysatis* from W. Australia. According to the author it is the species which Meyer (1909, p. 331) recorded from Shark's Bay as *Sepia latimanus*. The new species is described as being "smaller, and at all stages a narrower shell, with the posterior end less developed, and retaining the spine until adult. It was mentioned in connexion with the introduction of *Mesembrisepia* that the development of that genus suggested a relationship with *Amplisepia*, and the juvenile of the present species is not unlike that of the western species of *Mesembrisepia*, occurring where the ranges overlap".

Compared with *S. apama* "it is a smaller species, notably narrower at every stage of growth, with the striated area less elevated anteriorly and more elevated posteriorly, the last loculus short and depressed. The outer cone is advanced and well calcified, a fairly large horny area being exposed laterally. The spine is always present, and there is no dorsal sculpture nor any ventral sulcus, although sometimes a faint ventral groove may be noticed". The author gives the following measurements: 160 × 58 mm (36·5%); 185 × 62 mm (33·5%); 187 × 70 mm (37·5%); 192 × 70 mm (36·5%); 195 × 70 mm (36%); 215 × 78 (36·5%), which proves that with one exception all these bones are relatively a little broader than the type of *Sepia apama* and certainly not "notably narrower".

The fact that the spine is present is of no value as the specimen from Port Jackson described above (pl. 12, figs. 64 & 65) still shows the spine.

As we have not seen any original material of the species it is difficult to take a decision, but we do not believe that *Amplisepia parysatis* is specifically different from *S. apama*.

19. ***Sepia papuensis*** Hoyle, 1885
(Pl. 12, figs. 68 & 69; pl. 42, fig. 250)

Sepia papuensis Hoyle, 1885, p. 197; 1886, p. 126, pl. 16, figs. 13–23; Brazier, 1892, p. 11; Joubin, 1897, p. 102; Appellöf, 1898, p. 561; Adam, 1939*c*, p. 85; Voss, 1963, p. 35.

TYPE LOCALITY: Challenger Sta. 188, 9°59′S., 139°42′E., Arafura Sea, S. of Papua, 28 fms., gn. m.
GEOGRAPHICAL DISTRIBUTION: Arafura Sea; Philippines; Ternate.
MATERIAL:

a. Syntype, Challenger Sta. 188, 10. ix.1874; B.M. 1889.4.24.68; 1 ♂.

MEASUREMENTS:

			ANIMAL (IN % OF DORSAL MANTLE-LENGTH)						
Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a	♂	64	83	44	22	41	87	14	30

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	♂	64	30	30	30	—	12·5	—	1·6

SHELL (IN % OF SHELL-LENGTH)

Loc.	Sex.	L. in mm	W.	Th.	Str.z.	Spine	Observation
a	♂	63	35	8	65	3·2	pl. 12, figs. 68 & 69

DESCRIPTION: Contrary to Hoyle's original statement, this specimen is a male with a well developed penis filled with spermatophores, but without any trace of hectocotylization.

We have only a few details to add to the original description.

The tentacular club (pl. 42, fig. 250) has a broad swimming-membrane, extending about one-third of the club-length beyond the base of the club. The protective membranes are narrow and fused at the base. The tentacular suckers are arranged in five longitudinal series, those of the middle one being largest, followed by those of the fourth series counted from the dorsal side.

The shell is oval, broadest anterior to the middle, bluntly rounded at the anterior end and acuminately rounded at the posterior one. The dorsal surface has three longitudinal ribs, separated by two grooves, covered with rounded tubercles arranged along the growth-lines; the chitinous margins are rather broad (pl. 12, figs. 68 & 69).

The ventral surface has a distinct median groove. The limbs of the inner cone are fused to the outer cone which forms a chitinous ledge surrounding the posterior excavation. The spine is nearly straight, with a ventral keel.

The specimen examined shows a few, irregularly-arranged, small, rounded, compressed, papillae on the dorsal and ventral surface of mantle and fins and also on the head. Similar papillae are more regularly arranged on some of the arms; on the dorsal, dorso-lateral and ventro-lateral arms they are situated on or near the outer keels, especially distally. On the ventral arms they are not found on the keels but are irregularly scattered on the dorsal surfaces. We do not consider that these papillae have any special taxonomic value.

REMARKS: According to Hoyle (1886, p. 128), "This species agrees very closely with *Sepia singaporensis* Pfeffer, as regards the soft parts, but the shell is broader at the anterior extremity and the spine cannot be said to be 'zurück gebogen', although it slopes gently upwards; it is also near to *Sepia plangon* Gray, which seems, however, to be still nearer to Dr Pfeffer's species".

In fact the shells of these species differ in many respects. In *S. papuensis* the anterior margin is rounded and in *S. recurvirostra* it is acuminate. In the first species the chitinous margins are rather broad in the anterior part and narrow in the second. The mid-dorsal rib is broad in the first one and narrow in the second. The base of the spine is covered by a glaze in *S. papuensis*, but not in *S. recurvirostra*.

The spine is nearly straight, with a ventral keel, in *S. papuensis*, while in *S. recurvirostra* it is distinctly curved upwards and without any keel. In the first species the striated area of the ventral surface is rather flattened but is still convex with a broad shallow groove in the middle, flanked by two low ribs; in the second it is flatter, with a very narrow median groove. The anterior part of the inner cone is similar in both species, the limbs being situated at the lateral margins of the striated area. But in *S. papuensis* the posterior part of the inner cone remains completely fused to the outer cone, the posterior part of which forms a chitinous ledge surrounding the posterior excavation. In *S. recurvirostra* the posterior part of the inner cone constitutes a distinct ledge, separated from the

low posterior margin of the outer cone, but the space between the two is filled with a callous-like substance which is emarginate anteriorly.

In both species the anterior part of the striated area is separated from the outer cone on both sides by a narrow smooth zone; in the posterior part, these smooth zones are covered by the widened and flattened parts of the inner cone.

We agree with Hoyle that *S. papuensis* is closely related to *S. plangon*, the animal does not show any noteworthy differences; but the shell is distinctly different (see p. 44).

Sepia papuensis seems to be also closely related to *S. galei* Meyer, 1909 (p. 332, figs. 4–6), from Sharks Bay near Brown Station on Dirk Hartog. Cotton (1929, p. 91) was of the opinion that "The characters of this peculiarly shaped species render its reference to any described genus difficult".

Unfortunately the tentacular club is unknown, but judging from the description and the figures of the shell it strongly resembles *S. papuensis* and may even be conspecific.

Solitosepia submestus Iredale, 1926*a* (p. 238, pl. XXXV, figs. 3 & 4) also seems to be little different. This species, from Masthead Island, was described as: "Shell smaller than average *S. mestus*, narrower, more elongate, inner cone more strongly marked, the outer cone passing ventrally in front of the spine and showing a depression which is filled with chitin; the dorsal surface flatter and the ray sculpture more defined."

According to Iredale (1954, p. 65) this species "has been since found in various forms throughout northern Australia, and the distinction of the forms will depend on study of the animals". Among these forms, Iredale mentions: *S. papuensis*, *S. galei* and *S. occidua*, "These are of the same type, but the western Australian form, *galei*, must be accepted at present, *occidua*, however, falling until animals are examined". In fact *Solitosepia occidua* Cotton, 1929 (p. 88, pl. XIV, figs. 1 & 2) from W. Australia, which has been also described from the south coast of Bali by Adam (1939*c*, p. 85), is probably identical with *S. papuensis*. In 1939, Adam (p. 86) expressed the opinion that *S. mestus*, *S. glauerti* and *S. occidua* might be identical.

After examining the type of *Sepia mestus* Gray (see p. 46) it seems probable that *Sepia mestus* Iredale (*non* Gray) and *S. glauerti* Cotton, are related or identical (see p. 47), but that *Sepia occidua* is distinct. This latter species has the inner cone completely fused to the outer cone, even in its posterior portion, the same as in *S. papuensis*, *S. galei* and ? *S. submestus*.

Iredale (1954, p. 66) mentions "a strange specimen, apparently referable to a distinct species, was secured at Low Isles; this measured 99 mm by 37 mm, but in addition to its greater breadth, it was dark coloured and coarsely pustulose, all the other Queensland bones being pale and finely pustulose, and definitely narrower", which he named *Solitosepia lana*, without any detailed description or figure.

Iredale concludes (1954, p. 66): "As for the consideration of these allied forms, it seems best to admit the named forms, *submestus*, *lana*, *galei* and *papuensis*, as species, in the super-species or group of *papuensis*." He regards *occidua* as a synonym of *galei*.

Unfortunately, with the exception of *S. lana*, Iredale does not give any noteworthy characters which permit us to distinguish these forms or species. He speaks about broader and narrower shells without keeping in mind that generally female bones are relatively broader than male bones, and young bones broader than old ones. The known measurements of these species differ only very slightly as regards the relative width of the shell: *papuensis:* 34–36%; *galei:* 33·5–34%; *submestus:* 35·5–41·5% (the latter figure representing a very small specimen of 24 × 10 mm); *occidua:* 37–39·5%; *lana:* 37·5%. The fact that Iredale (1954, p. 66) regards *S. occidua* identical with *S. galei* proves that the relative width cannot be used in this group. According to him, the inner cone of western bones seems to be consistently narrower than in the eastern bones, but the published figures do not show this difference.

Finally, Iredale (1954, p. 66, pl. V, figs. 17 & 18) described a new species, *Solitosepia genista*,

from Broome, N.W. Australia, which he first confused with *S. galei*. This new species has the shell "elongate, narrow, recalling *plangon* in appearance, the inner cone well developed, seen crossing but not obscuring the siphonal cavity, the ventral surface rather flattened, the striated area not deeply excavate, the last loculus long, no ventral sulcus, but a slight indication of a groove medially. The spine is keeled, a little recurved. The dorsal surface is rayed with three rays, forming a median strong rib with the outer radials weakly displayed. The outer cone is slightly calcified". The type measures 67 × 23 mm (34·5%) and consequently is relatively even broader than *galei*, but narrower than *occidua*; other specimens measured: 46 × 16 mm (34·5%), 59 × 23 mm (39%), and 69 × 22 mm (32%).

The published figures bear not the slightest resemblance to *S. plangon*. According to the author "it recalled *singaporensis*", which does not look at all like it. In his opinion "It is more like the narrow *papuensis*, but the inner cone is not produced". In the first place, *S. papuensis* is not narrower than *S. galei*, unless we consider *S. occidua* as synonymous with the latter (see p. 40) and, secondly, the inner cone of *S. papuensis* is completely fused to the outer cone and cannot be called "produced".

Without having seen original material we cannot decide in how far *S. genista* really differs from *S. papuensis*.

As we point out on p. 42, *S. prionota* Voss, 1962, is probably identical with *S. papuensis*, but we have to wait for the final description of the former species, the preliminary account of which is not sufficiently detailed to take a decision.[1]

20. ***Sepia prionota*** Voss, 1962
(Pl. 4, figs 22 & 23; pl. 42, fig. 252)

Sepia prionota Voss, 1962*a*, p. 169; 1963, p. 24, pl. I, figs. *f* & *g*; text-figs. 1*a–e*.

TYPE LOCALITY: off Sirun Island, Sulu Archipelago, Tawi Tawi group, 44 m.
GEOGRAPHICAL DISTRIBUTION: Sulu Archipelago.

DESCRIPTION: This species is based on four females with a mantle-length of 26–61 mm. The original preliminary description does not give many details but the author has kindly put at our disposal some drawings and the photographic prints of the dorsal and ventral surface of the shell.

The mantle is rather slender, about half as wide as long. The dorsal margin projects strongly and is broadly rounded. The buccal membrane is devoid of suckers. The arms are in the order 4.1 = 2 = 3, the ventral ones being about 34 – 40% of the mantle-length. All the arms are strongly compressed with "a keel on all but the ventral arms, consisting of a series of about 6–8 high rounded lappets originating at the base of the arms and extending to near the tip". The suckers are quadriserial on all the arms. The tentacles are stout, moderately long, and compressed.

The clubs are small and expanded; the suckers are arranged in six rows, four of the second dorsal row being greatly enlarged.

Judging from the figure, the swimming-membrane extends beyond the base of the club and the protective membranes seem to be fused at the base.

"The shell is narrow, rounded both anteriorly and posteriorly and with a short stout spine. The ventral surface is concave throughout." The photograph of the dorsal surface shows rather wide chitinous margins in the anterior portion; it is impossible to judge if there are any dorsal ribs or furrows. That of the ventral surface shows a long striated area with regularly convex striae and perhaps a faint, narrow, median groove. The limbs of the inner cone are well-developed and seem to

[1] Since the manuscript was set up in type we have examined a paratype of *S. prionota* and see no reason for keeping the two species separate.

be completely fused to the outer cone. The striated area appears to be separated from the latter by rather wide smooth zones. We do not know if the spine has any keels.

REMARKS: We have to wait for the more complete final description of this species to be able to discuss its relationship to other species. But as far as we can judge for the moment it does not seem to differ in any noteworthy respect from *S. papuensis* Hoyle, 1885 (see p. 41). According to Voss (1962, p. 170) the saw-like keels on the arms of *S. prionota* seem a sufficient character to separate this species from all others presently known from the Indo-Pacific region.

As we pointed out on p. 39, the type-specimen of *S. papuensis* also shows a number of papillae situated on, or near the outer keel of the dorsal, dorso-lateral and ventro-lateral arms. These papillae which were not mentioned in the original description are probably the same as the lappets described by Voss. The shells seem to be exactly alike, but the author did not state if the spine is keeled.

As the male specimen of *S. papuensis* does not show any trace of hectocotylization, we wonder if the female specimens reported for *S. prionota* are really all females; only by opening the mantle can this be verified.

21. ***Sepia plangon*** Gray, 1849
(Pl. 13, figs. 70–73; pl. 44, fig. 267)

Sepia plangon Gray, 1849, p. 104; Tryon, 1879, p. 194; Hoyle, 1886, p. 128; Brazier, 1892, p. 11; Hedley, 1918, p. M.33.
Acanthosepion plangon, Rochebrune, 1884, p. 105; Adam, 1944, p. 231.
Solitosepia plangon, Iredale, 1926, p. 190, pl. XXIII, figs. 3 & 4; 1954, p. 66; Iredale & McMichael, 1962, p. 98.
Solitosepia plangon adhaesa Iredale, 1926*a*, p. 238.
? *Sepia cultrata* Hedley, 1918, p. M.33 (*non* Hoyle, 1886).
? *Sepia polynesica* Pfeffer, 1884, p. 11, figs. 14 & 14*a*.

TYPE LOCALITIES: Port Jackson, Australia (*Sepia plangon*); North-West Islet, Capricorn Group (*Sepia plangon adhaesa*).

GEOGRAPHICAL DISTRIBUTION: E. Australia; Lord Howe Island.

MATERIAL:

a. Port Jackson (Robertson, Antarctic Expedition); B.M. 1963126W; 1 animal without shell (syntype).
b. Australia (Sinclair); B.M. 1842.11.9.85; 1 shell, broken (syntype).
c. Port Jackson, Australia (Antarctic Expedition, Admiralty); 1 ♂. B.M. 196374W.
d. Port Jackson, Australia (Admiralty); 2 ♀ ♀. B.M. 196375W.
e. Sow and Pigs Bank, Port Jackson, 3 fms. (Pres. Brazier); B.M. 1879.5.21.804; 1 young sp.
f. Queensland, Caloundra, north of Brisbane (Iredale); B.M. 1915.8.28.1; 1 shell.

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
c	♂	95	91	42	18	34	87	5·5	21+
d	♀	70	90	46	21	38	86	7	31
	♀	56	91	48	27	33	89	7	30

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
c	♂	95	28	31	42	120	11·5	1·25	1·25
d	♀	70	29	34	39	—	—	1·30	—
	♀	56	27	27	39	—	—	1·10	—

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
c	♂	94	26	9	67	2·1+	
d	♀	69	28	9	67	1·4+	pl. 13, figs. 70 & 71
f	—	83	29·5	8	±69	6	pl. 13, figs. 72 & 73
Manly Beach		110	27				Iredale, 1926
Yeppoon		100	28				Iredale, 1954
?		135	26				,,
?		39	33·5				,,
?		42	33·5				,,
?		48	32·5				,,
?		59	32				,,
?		61	31				,,
?		72	30·5				,,
?		73	29				,,
?		77	30				,,
?		82	29·5				,,
?		83	30				,,
			Sepia plangon adhaesa				
North-west I.		88	29·5				Iredale, 1926*a*

DESCRIPTION: The type-specimen is greatly macerated, but its tentacular club (pl. 44, fig. 267) seems to be similar to that of *Sepia papuensis* Hoyle (see p. 39). Hoyle (1886, p. 128) described this specimen, the shell of which we were unable to find, but according to this author it "resembles that of *Sepia singaporensis* Pfeffer, more nearly than any other known to me; the only differences being that the incurving of the margins of the loculi in the striated area is a little more pronounced, and there is a ridge or keel on the ventral surface of the spine (as in *Sepia cultrata*) not recorded by Dr. Pfeffer. These two species are much alike, but they differ in the arrangement of the suckers on the tentacular club".

The other shell (*b*) mentioned by Gray (1849, p. 104) is broken but seems to possess a spine. There is a strong callus between the inner and the outer cone; the ventral surface has a deep median groove in the striated area, the striae forming a long, acutely-projecting angle.

In the male specimen from Port Jackson (*c*) the mantle is elongate-oval in shape with a projecting dorsal margin, reaching the mid-level of the eyes; it has a slightly concave ventral margin. The fins are narrow, not reaching the mantle-margin. The dorsal arms have poorly developed swimming membranes, the dorso-lateral and ventro-lateral ones are keeled at the outer sides and the ventral ones have well developed swimming-membranes. The suckers of the proximal two-thirds of the ventro-lateral arms have a greater diameter than on the other arms; all the suckers are quadriserial. The left ventral arm is hectocotylized, laterally compressed, with better developed protective membranes. The transformed portion is very little differentiated; at the base there are about five transverse series of normal suckers, followed by about five series of slightly smaller ones, especially on the dorsal side; the rest of the arm has suckers of normal size.

The tentacular club is exactly like that in *Sepia papuensis* (see p. 39), the sucker-bearing part being nearly completely detached from the stem by a deep groove between the stem and the dorsal protective membrane. The strongly developed swimming-membrane is slightly larger than that of *S. papuensis* and extends for about one third of the club-length beyond the base of the club. The suckers are arranged in five longitudinal series, those of the middle one being biggest, followed by those of the fourth series, counted from the dorsal side.

The shell is elongate, rounded at its posterior end and acuminate at the anterior one (pl. 13, figs. 70–73). The dorsal surface is finely granulous with two broad chitinous marginal portions, the median part showing a slight indication of three longitudinal ribs. The ventral surface has a long striated area, deeply hollowed out by a median groove which continues, less deeply, on the last loculus. The median groove is limited by two ribs giving a wavy appearance to the striae, which form a strongly acute projecting angle. The striated area is separated from the outer cone by two lateral zones which are slightly concave and transversely striated. The slightly raised limbs of the inner cone separate these lateral portions from the central area. In its posterior part the inner cone is broadened, flattened out and nearly completely fused with the outer cone, except at its posterior margin which is slightly raised into a ledge. This ledge is not free, but is connected to the outer cone by a thick blackish callus. The outer cone is widened in its posterior part and surrounds the inner cone with which it is connected by the callous substance which forms a posteriorly curved ledge. The spine is broken but shows a distinct ventral keel.

The female specimens (*d*) differ from the male in not having larger arm-suckers on the ventro-lateral arms. The buccal membrane is devoid of suckers.

Remarks: Iredale (1926*a*, p. 238) described the subspecies *adhaesa* as follows:

> "Shell narrower, more elongate, the inner cone more strongly developed, the outer cone advancing in front of the spine as a chitinous rim; the dorsal sculpture more pronounced and the dorsal surface more flattened than in the typical form."

According to Iredale this is "the species recorded by Hedley as *S. cultrata* Hoyle in error".

In 1954, Iredale (p. 66) considered *adhaesa* to be the northern form of *Sepia plangon*. In this text it is not clear which specimens he considers to belong to the sub-species, but he notes (p. 67) "that the northern bones of *plangon* (*adhaesa*) show a tendency to recurve the spine, whilst in the southern *plangon* the spine is very straight". In any case Iredale's own measurements show that *adhaesa* does not have a narrower shell, it is even slightly broader than the specimens from Port Jackson!

The animals of *Sepia plangon*, *S. recurvirostra* and *S. papuensis* are very much alike as regards the tentacular club. As to the shells of these species, they have much in common but there are several differences. On p. 39 we pointed out the differences between *S. papuensis* and *S. recurvirostra*. The shell of the latter resembles more nearly that of *S. plangon*, but the spine has no keel and the dorsal surface lacks the broad marginal chitinous zones whereas the outline of the striae of the ventral surface is completely different; *S. recurvirostra* lacks the deep median groove and hence the protruding angular form of the striae. The inner cone has the same general appearance, but in *S. recurvirostra* the posterior ledge is more elevated and less fused to the outer cone; the callous-like substance, uniting the inner and outer cone, is thick and anteriorly excavated, but in *S. plangon* it constitutes a thinner ledge-like formation which curves outwards posteriorly. It looks more like that of *S. papuensis*, but in that species it is a nearly straight, much thinner ledge. The general form of the shell and the outline of the ventral striae are completely different in *S. papuensis* and *S. plangon*.

As regards *S. polynesica* Pfeffer, 1884, the shell and the tentacular club of *S. plangon* are very like it. As the shell of *S. polynesica* could not be traced and the animal was badly macerated it is impossible to verify this question, but we are of the opinion that *S. polynesica* is identical with *S. plangon*.

22. *Sepia mestus* Gray, 1849

(Pl. 13, figs. 74 & 75; pl. 14, figs. 76–79; pl. 15, figs. 80–83; pl. 46, fig. 274)

Sepia mestus Gray, 1849, p. 108; Tryon, 1879, p. 197; Hoyle, 1886, p. 135, fig. 5; Brazier, 1892, p. 12; ? Tate & May, 1901, p. 351; ? Chapman, 1912, p. 25; Hedley, 1918, p. M.33; Adam, 1939*c*, pp. 52, 86.
? *Solitosepia mestus*, Iredale, 1926, p. 189, pl. XXI, figs. 4 & 5; 1954, p. 65; Iredale & McMichael, 1962, p. 98.
Ascarosepion verreauxi Rochebrune, 1884, p. 98, pl. V, fig. 2; Adam, 1944, p. 229.
Solitosepia liliana Iredale, 1926, p. 188, pl. XXI, figs. 1–3; 1954, p. 64; Iredale & McMichael, 1962, p. 98.

TYPE LOCALITIES: Australia (*Sepia mestus*); Sydney (*Ascarosepion verreauxi*); Manly Beach, N.S. Wales (*Solitosepia liliana*).

GEOGRAPHICAL DISTRIBUTION: Australia.

MATERIAL:

a. Australia (Sinclair); B.M.1842.11.9.54 and B.M. 1842.11.11.13; 2 shells (syntypes).

b. Caloundra, north of Brisbane, Queensland (Iredale); B.M.1915.8.28.2–3; 2 shells (with an annotation: "*Sepia* sp. allied to *S. mestus* Gray").

c. ? N. China (Purchased Jamrach); B.M. 1863.5.1.6; 1 ♀.

MEASUREMENTS:

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.[1]	Str.z.	Spine	Observations
a	—	71	44+	7·7	±62	5	
		51	42	9·8	±59	5	pl. 14, figs. 76 & 77
b	—	91	48	7·1	±66	6	pl. 14, figs. 78 & 79
		64	52	8·6	±55	5·5+	pl. 15, figs. 80 & 81
c	♀	46·5	41	11	56	5·4	pl. 13, figs. 74 & 75

Comparative table of the measurements of the shells of different species allied to or identical with *Sepia mestus* (in % of shell-length).

Species	Locality	L. in mm	W.	Str.z.	Spine	Observations
S. verreauxi	Sydney	137	40	75	5	Type, pl. 15, figs. 82 & 83
S. mestus	N.S. Wales	57	37			Iredale, 1926, fig. [2]
,,	,,	40	45			,,
,,	,,	70	43			Iredale, 1954
,,	Manly	92	42·5			,,
,,	Eden	87	42·5			,,
,,	Briby Isl.	90	44·5			,,
,,	?	24	50			,,
,,	?	40	45			,,
,,	?	55	43·5			,,
,,	?	63	39·5			,,
,,	?	69	39			,,
,,	?	90[3]	33·5			,,
,,	?	75	40			,,
,,	?	78	43·5			,,
,,	?	81	42			,,
S. liliana	Manly Beach	114	44·5			Iredale, 1926

Table continued overleaf

[1] The thickness is measured in the median area, the outer margin being higher.

[2] In 1954, Iredale (p. 65) stated that the dimensions were all given inaccurately in 1926, and that the average dimensions would be about 70 × 30 mm. The figure that Iredale published in 1926 (pl. XXI, figs. 4 & 5) shows a width of 38%.

[3] This may be a printing error for "70"; in that case the width would be 43%.

Species	Locality	L. in mm	W.	Str.z.	Spine	Observations
S. liliana	Manly Beach	90	50			Iredale, 1926
,,	? ,,	138	47			Iredale, 1954
,,	?	19	63			,,
,,	?	34	56			,,
,,	?	53	49			,,
,,	?	56	46·5			,,
,,	?	65	46			,,
,,	?	64	51·5			,,
,,	?	80	50			,,
,,	?	93	49·5			,,
,,	?	100	50			,,
,,	?	102	47			,,
,,	?	109	49·5			,,
,,	N. Queensland	38	53			,,
,,	,,	56	53·5			,,
,,	,,	82	47·5			,,
,,	Eden	119	49			,,

Description: The animal of this species is not known for certain. Both the type shells are in rather good condition, although the ventral surface is rather worn (pl. 14, figs. 76 & 77). The shell is broadly oval, slightly acuminate at its anterior end and with a strong, ventrally-keeled posterior spine, which is directed slightly upwards in the smaller specimen.

The dorsal side is convex with an indistinct median rib. Nearly the whole surface is reticulate granulous. The ventral surface is very flat, the whole striated area concave and the last loculus flat or slightly convex. Unfortunately this ventral surface is rather worn and does not show the exact outline of the striae which seem to be regularly rounded.

The limbs of the inner cone are very broad in the posterior half and are completely fused to the outer cone, with the exception of the outer margin which is slightly raised as a flat rim (approximately as in *Sepia savignyi*, but less developed).

The lateral parts of the outer cone are broad and continuous behind the inner cone as a very narrow margin. The spine has a strong wedge-like ventral keel.

Hoyle (1886, p. 135, fig. 5) published a drawing of one of the type shells, which shows a distinct narrow groove in the middle of the ventral surface. Actually both types do not show the slightest indication of such a groove.

The two shells from Caloundra (pl. 14, figs. 78 & 79; pl. 15, figs. 80 & 81) are broader than the type-shells but do not seem to differ in other respects. The larger one shows a very faint ventral median groove and in both there are some even fainter radiating grooves which give a slightly wavy outline to the striae.

The female specimen from N. China is in a rather poor macerated state and does not allow a detailed description. Its dorsal mantle-margin is well produced and rounded. The arms are short, the suckers quadriserial. The tentacular club (pl. 46, fig. 274) has a well developed swimming-membrane, about one and a half times as long as the club; the protective membranes remain separated at the base of the club.

The tentacular suckers seem to be arranged in five or six longitudinal series, but may in fact form oblique transverse rows of eight, the third row of suckers in the middle of the club being larger than the others.

The shell (pl. 13, figs. 74 & 75) does not show any noteworthy differences compared with those described above, except that the rim of the inner cone, is slightly narrower and also the ventral surface is less concave in the anterior portion of the striated area and practically flat, even convex at the margins.

As long as the animals of both the Australian and the Chinese specimens (if the last locality is exact) are not known or better known, this identification remains somewhat doubtful.

Remarks: As the photographs of the type-specimen prove, there is not the slightest doubt that *Ascarosepion verreauxi* Rochebrune 1884, is identical with *Sepia mestus*. The animal of *S. verreauxi* which Adam re-examined (1944, p. 229) is in a poor state of preservation; its tentacular club shows five or six longitudinal series of small suckers, the median ones being larger than the others.

In 1939, Adam (p. 52) had already pointed out Iredale's mistake (1926, p. 194) in considering *Ascarosepion verreauxi* to be an *Amplisepia* allied to *A. apama* (Gray) and even to be the eastern representative of the latter. Adam's opinion was based on the original description and figures of *Ascarosepion verreauxi* and was substantiated by the study of the type-specimen (Adam, 1944, p. 229).

Unfortunately, Iredale ignored these publications and in 1954 (p. 71) still mentioned *verreauxi* as the eastern form of *Amplisepia apama*.

We hope that the reproduction of a photograph (pl. 15, figs. 82 & 83) of the type of *Ascarosepiou verreauxi*, for which we are indebted to Professor Fischer-Piette (Paris), will put an end to this unbelievable confusion for good.

A second problem is that the specimens described and figured by Iredale (1926, p. 189, pl. XXI, figs. 4 & 5) as "*Solitosepia mestus*" do not seem to belong to this species, their general form and the outline of the striae of the striated area being quite different. On the other hand, the type-species of *Solitosepia: S. liliana* Iredale, 1926, resembles more closely the true *S. uestus* Gray. The specimens from Caloundra, described on page 46, belong without any doubt to *S. liliana*, but they only differ from the types of *S. mestus* in their slightly broader shape which is probably only a sexual character.

The genus *Ascarosepiou* Rochebrune, 1884, was based on two species: the first mentioned being *A. verreauxi* Rochebrune, the second *A. fischeri* (Lafont, 1871); the latter is a form of *Sepia officinalis*, identical with *S. officinalis filliouxi* (see Cuénot, 1927, p. 273 and Adam, 1941, p. 88).

Considering *S. verreauxi* as the type-species of *Ascarosepiou*[1] and as conspecific with *S. uestus* Gray (*non* Iredale) and with *S. liliana* Iredale, we may conclude that *Solitosepia* Iredale, 1926, is a synonym of *Ascarosepion* Rochebrune, 1884, the latter name having priority.

For the moment we cannot decide where the specimens mentioned by Iredale as *S. uestus* belong; their shell has a different form, a deeper ventro-median groove and an angular outline of the striae. They seem to resemble *S. glauerti* Cotton, 1929 (p. 87, pl. XIV, figs. 3 & 4), from Rottnest Island and Cottesloe, which Iredale (1954, p. 77) suggested to be an immature of a species of *Acauthosepiou*. This is not possible because *S. glauerti* has a ventrally keeled spine.

Chapman's (1912, p. 25) statement that *Sepia mestus* Gray is a broad form of *S. cultrata* Hoyle is certainly erroneous (see p. 60).

Iredale (1926, p. 188) gave the following diagnosis of his genus *Solitosepia:* "Shell of medium size, the inner cone well developed, the spine keeled. While these features distinguish this group the members disagree in other details so much that the species may not prove congeneric later." We fully agree with the remark that the species placed in *Solitosepia* disagree in many details (see p. 105) but in our opinion the differences are not of a generic character and we disapprove of the splitting up of the genus *Sepia* without detailed study of both animals and shells.

We discuss the species classified by Iredale several times in this study. But there remains one species we were unable to retrace among our material: *Solitosepia rozella* Iredale, 1926 (p. 190, pl. XXI, figs. 6 & 7) and its sub-species *peregrina* Iredale, 1926*a* (p. 238). This species was described from Manly Beach, New South Wales; it is characterized by a deep median sulcus, an angular outline of the striae and a large, deep, rose-coloured inner cone, the dorsal surface is also rose coloured,

[1] Type-species designated by Hoyle (1910, p. 408). See p. 147 of this review.

finely pustulose, with three ribs. The sub-species, from North-West Islet, is smaller, comparatively broader, the inner cone is wider, the rose colour is restricted to a narrow band and the dorsal sculpture is more pronounced. The relative width of the shell of *S. rozella* varies between 31 and 44%, the smaller shells being relatively broader (Iredale, 1954, p. 67); the type of *peregrina* measured 89 × 34 mm (38%).

23. ***Sepia novaehollandiae*** Hoyle, 1909
(Pl. 15, figs. 84–90)

Sepia australis Férussac, 1835, pl. VII, fig. 4; d'Orbigny, 1845, p. 294; Férussac & d'Orbigny, 1848, p. 285, pl. VII, fig. 4; Hoyle, 1886, pp. 22, 220 (*non* Quoy & Gaimard, 1832).
Sepia novaehollandiae Hoyle, 1909, p. 266; Macpherson & Chapple, 1951, p. 156.
Mesembrisepia novaehollandiae, Iredale, 1926, p. 191; 1954, p. 68; Verco & Cotton, 1928, p. 127; Cotton, 1929, p. 88; 1931, p. 40, fig. 3; Hope Macpherson & Gabriel, 1962, p. 409.
Sepia (*Mesembrisepia*) *novaehollandiae*, Cotton & Godfrey, 1940, p. 428, figs. 416–418.
? *Sepia dannevigi* Berry, 1918, p. 264, figs. 51–55, pl. LXXIII, pl. LXXIV, figs. 1 & 2; Verco & Cotton, 1928, p. 127.

TYPE LOCALITY: Kangaroo Island, S. Australia.
GEOGRAPHICAL DISTRIBUTION: S. Australia; ? W. Australia.
MATERIAL:

a. Adelaide (Wigram); B.M. 1890.3.24.280–2; 3 shells.
b. Semaphore, S. Australia (Pres. Cotton); B.M. 1962256W.; 5 shells.

DESCRIPTION: The three shells (L = 42, 47 and 48 mm) from Adelaide correspond fairly well with Férussac & d'Orbigny's description and figures of their *Sepia australis* (*non* Quoy & Gaimard), with one exception—there is only a very faint indication of a ventro-median groove (pl. 15, figs. 84 & 85).

The dorsal surface has three very faint ribs; in the anterior portion the reticulate granulation is barely indicated but becomes more and more distinct in the posterior part, where the granules form long radiating tuberculous lines, except around the base of the spine, where they are round.

The spine is slightly turned upwards.

The ventral surface shows a long striated area; it is concave in its posterior part and a little convex anteriorly, with slightly convex striae. On both sides of the striated zone there is a narrow smooth area. The limbs of the inner cone are completely fused to the outer cone and surround a shallow posterior depression. The outer cone continues as a narrow margin behind the inner cone.

REMARKS: According to Cotton (1929, p. 88): "This appears to be the commonest and most variable species found in the Adelaidean region. Among hundreds of specimens from South and West Australia the numerous variants are not separable into any distinct varieties."

Cotton & Godfrey (1940, p. 428) described the animal of this species. The dorsal mantle-margin projects strongly. The arm-suckers are quadriserial. The tentacular club is small; its swimming-membrane extends beyond the base of the club and the suckers are "excessively numerous and minute, in 10 to 12 longitudinal series at the middle of the club". These authors consider *Sepia dannevigi* Berry to be synonymous with *S. novaehollandiae*.

Iredale (1926, p. 190) created a new genus *Mesembrisepia* for *M. macandrewi* n. sp. from New South Wales, which according to him (p. 191) is "the Peronian representative of *S. novaehollandiae* Hoyle, of which *S. chirotrema* Berry appears to be the benthal form".

Cotton (1929, p. 89) mentioned that this latter species "is easily distinguishable from *M. novaehollandiae* (Hoyle) by the coarser sculpture of its dorsum, stronger spine, and deeper ventral sulcus.

It is probably the deeper water form of *M. novaehollandiae*, in which case it should be named *M.* (*novaehollandiae*) *chirotrema* Hoyle". Cotton & Godfrey (1940, p. 428) however state that *Sepia chirotrema* is "a distinct deep water species related to *S.* (*Mesembrisepia*) *novaehollandiae*", and they add: "A South African species *capensis* d'Orbigny = *australis* Quoy & Gaimard, is distinct but of the same sub-genus (Berry)."

As regards this latter statement, it is correct that Berry (1918, p. 275) compared *Sepia chirotrema* with *S. capensis* d'Orbigny (= *S. australis* Quoy & Gaimard), particularly because of "the strongly elaborated mechanism of the tentacle club". In fact, the tentacular club of *S. chirotrema* is even more like that of *S. tuberculata* and *S. papillata*, the protective membranes being united at the base.

But Berry pointed out several important differences and by no means concludes that the South African species belongs to the same sub-genus as *S. chirotrema* (this sub-genus had not yet been created by Iredale).

A much more serious question is the description mentioned above of the animal of *S. novaehollandiae*.

In fact, the description of the animal and the figures, given by Cotton & Godfrey (1940, p. 428, figs. 416 & 417) are textually copied from Berry's description and figures of *S. dannevigi* (1918, p. 264, figs. 54 & 55, pl. LXXIII, pl. LXXIV, figs. 1 & 2).

The shell of *S. novaehollandiae*, figured by Cotton & Godfrey (1940, fig. 418) does not belong to the animal represented in fig. 417, because Berry (1918, p. 265) stated: "Gladius (sepiostaire) unknown."

In his opinion this defeats "any possible attempt to identify it with any of the named forms heretofore known from the shell alone".

As not a single animal of *Sepia novaehollandiae* seems to have been described for certain, it is premature to consider *Sepia dannevigi* to be identical with it; in fact, we are almost certain that it is not.

We had the opportunity to examine five cuttlebones in the collections of the Royal Institute of Natural Sciences (Brussels) collected by Kaspiew in Adelaide (S. Australia). These shells seem to belong to *Sepia novaehollandiae*. The dorsal surface is faintly rose-coloured, especially in the posterior part and shows a very weak median rib. The chitinous margins are rather broad in the anterior part. The anterior portion is very finely granulous, the granules being more or less arranged along the growth-lines. In the posterior portion the granules are very coarse, partly arranged in longitudinal lines, radiating from the spine. The base of the spine is swollen on the dorsal side and provided with thick lateral ridges, which are partly covered with coarse radiating granules. The ventral surface is rather variable, with a more or less pronounced sulcus, the outline of the striae of the striated zone being strongly angular when the median groove is deep but less so when the latter is shallower and the shell flatter. The sulcus is limited by two more or less pronounced ribs, separating the median groove from the marginal areas which are flat or concave. The inner cone has rather broad limbs, which are completely fused to the outer cone, the posterior part being slightly raised as a rounded ridge. The outer cone is continuous as a thin chitinous margin in well preserved specimens, otherwise it seems to be interrupted between the inner cone and the spine. The latter is very strong, without any keels and straight or slightly turned upwards. There is a distinct depression at the ventral base of the spine.

The relative measurements of these shells are given in the following comparative table, in which we have assembled the data concerning the species regarded by Iredale (1954) as belonging to *Mesembrisepia*.

Of these five species only the animals of *S. irvingi* and *S. chirotrema* have been described. The tentacular club of the first one bears five rows of suckers, those of the median series being distinctly larger while those of the second dorsal series are slightly larger than the other ones; the protective

Locality	L. in mm	W.	Th.	Str.z.	Spine	Author
		Sepia novaehollandiae Hoyle				
Adelaide (S. Australia)	125	32	12·0	64	5·6	this paper
(Coll. I.R.S.N.)	115	32	9·5	63	5·6	
	113	34	11·5	68	5·8	
	112	33	10·5	±62	5·8	
	111	35	11·5	68	5·8	
Kangaroo Island (S. Australia)	78	30				d'Orbigny, 1848
Cottesloe (W. Australia)	150	30	10			Cotton, 1929
Robe (S. Australia)	140	35·5				Cotton, 1931
		Sepia irvingi Meyer				
Cockburn Sound (W. Australia)	115	35·5	11			Meyer, 1909
Point Cloates (W. Australia)	142	28	11			Iredale, 1954
Geraldton	130	31				,,
	104	35·5				
	78	31				
	62	32				
Pelsart Island	173	26				
		Sepia macandrewi (Iredale)				
Shellharbour (N.S. Wales)	170	33				Iredale, 1926
Stanley (N.W. Tasmania)	183	29				Iredale, 1954
	174	29				
	171	29				
	155	31·5				
	145	31				
		Sepia ostanes (Iredale)				
Stanley (N.W. Tasmania)	140	35·5				Iredale, 1954
Marrawah (W. Tasmania)	145	34·5				,,
	128	35				,,
Burnie (N.W. Tasmania)	130	37				,,
Esperance (S.W. Australia)	110	33·5				,,
	90	38				,,
Perth	130	35·5				,,
		Sepia chirotrema Berry				
S. of Eucla (W. Australia)	168	30				Berry, 1918
Cottesloe and Rottnest Island (W. Australia)	145	29·5	9			Cotton, 1929
Robe (S. Australia)	160	26·5				Cotton, 1931
Joslin (S. Australia)	200	25				Iredale, 1954
Rottnest Island (W. Australia)	125	32				,,
Geraldton	135	33·5				,,
Nr. Cape Leeuwin	123	31·5				,,
Pelsart Island	100	38				,,

membranes seem to be separated at the base. The club of *S. chirotrema* is quite different. The swimming-membrane, which extends slightly beyond the base of the club is very broad. The protective membranes are fused at the base, the dorsal one "thick and fleshy, unique in not being everywhere continuous with the face of the club, but perforated by three large openings or fenestrae . . . " The suckers are very characteristic: at the base there are four or five of rather small ones, "one of them quite conspicuously (twice or thrice) larger than the remainder; succeeding these in centre of club proper, three gigantic suckers, the middle one is largest, borne on long pedicels originating in three large pockets just opposite the fenestrae in the dorsal membrane; flanking these and alternating with them by reason of being borne on the inner face of the dorsal membrane (one respectively just above each supporting pillar) are two suckers rather smaller than the largest of the proximal group; two fleshy folds springing from the dorsal membrane, one below each of these suckers, traverse the face of the club and are continuous with similar ridges forming the supports of the ventral membrane,

finally terminating near the margin of the said membrane in three small diverging buttresses; springing from the two angles of these buttresses, two very small suckers borne by each ventral ridge, or four suckers in all in the ventral row, each pair thus corresponding to a single dorsal sucker". The author rightly concludes that although the suckers on the main part of the club seem to be arranged in three rows, they are actually in four rows. The distal fourth of the club bears 40–48 crowded small suckers in four to six series.

If the structure of the tentacular club has any systematic value, and in our opinion, it certainly has, we do not think that it is justifiable to place two species as different in this respect as *Sepia irvingi* and *S. chirotrema* in one special genus, *Mesembrisepia* Iredale, 1926, separated from other Sepiidae. As we mentioned above, Iredale (1926, p. 190) created this genus for his *Mesembrisepia macandrewi*, and stated:

> "The development of the spine is the characteristic feature in which it differs from *Solitosepia* and suggests a relationship with *Amplisepia*, which may be later discussed. The shell is large for the medium series, elongately oval, inner cone well marked and lengthened, spine round and almost pinched off and directed ventrally."

We do not know which relationship with *Amplisepia* the author had in view, because he does not mention it in discussing this other genus.

Unfortunately the original figure of the cuttlebone of *Sepia chirotrema* (see Berry, 1918, p. 271, figs. 58 & 59) is not very clear and partially reconstructed, the spine seems to be incomplete and the author (p. 272) describes it as short, stout and blunt, without mentioning if it is keeled or not.

Cotton & Godfrey (1940, p. 422, figs. 410–415) have described and figured this species. Unfortunately their description of the animal and the shell is an abbreviated copy of the original description, the figures of the animal are copied from Berry's original figures (pl. LXXIV, figs. 3, 5, 6–9, pl. LXXV–LXXVII; text-figs. 60 & 61), but their figure of the shell (fig. 413) is quite different from the original one and we are not even sure that it belongs to *S. chirotrema*. It is apparently related to the other species of *Mesembrisepia* but seems to be characterized by the very narrow general form and the pronounced wing-like formation of the posterior part of the outer cone.

As to the other species described or mentioned by Iredale (1926, and 1954) as belonging to *Mesembrisepia*, we know nothing about the animals and we have to rely on his descriptions and his figures of the shells.

If the shells we described from Adelaide (S. Australia) are really *Sepia novaehollandiae* Hoyle, the width of the shell of this species varies between 30 and 35% of the length.

Iredale (1954, p. 68) states under *Mesembrisepia novaehollandiae:* "The New South Wales representative, *macandrewi* is a broader shell, and there is a slight variation, which may be sexual, in the breadth." But according to his own figures, the type of *M. macandrewi* has a width of 33% and he mentions (p. 70) a series from Stanley, north-west Tasmania, which recall this species, but are a little narrower, their width varies between 29 and 31·5%. On the other hand, he states that:—

> "it may be found on the eastern Victoria coast, and to the north and east of Tasmania, but the bones from north-west and west of Tasmania are broader, and represent a different form. The western Victoria bones may be *novaehollandiae*, or an intermediate form."

Finally the author mentions that the bone which Chapman (1912, p. 25) reported from Torquay (Victoria) as being *Sepia latimanus* Quoy & Gaimard, is of a *novaehollandiae* form, judging by the figure. This bone measured 135 mm in length, and not 138 mm as Iredale mentioned. All these remarks under *M. macandrewi* are rather confusing and the relative figures of our comparative table (p. 50) show that if the width of the shell is the only distinctive difference between *M. novaehollandiae* and *M. macandrewi*, there is no difference at all.

As for *Sepia irvingi* Meyer, 1909, Cotton (1929, p. 91) was of the opinion that this species "is

possibly a variant of *Mesembrisepia novaehollandiae* Hoyle". In fact this species seems to be absolutely identical with the above mentioned shells from Adelaide. The width of the shell of a female-type specimen measures 35·5% of the length.

Nevertheless, Iredale (1954, p. 69) pretends that: "the Western Australian bones, north of the Swan River, are constant enough, in their narrowness and prominent ventral surface anteriorly, to be admitted as different." He concludes that the western name (*S. irvingi*) may be used for these bones until the matter is decided by study of animals.

Among the shells Iredale attributes to *S. irvingi* two have a width of 26 and 28%, the other ones vary between 31 and 35·5%, which proves that in the mean *S. irvingi* is not narrower than *S. novaehollandiae* and both may even be broader than *S. macandrewi*.

Mesembrisepia ostanes Iredale, 1954, seems to have a slightly broader shell (see p. 50), "with anterior ventral shallow, not elevated", showing a round depression. According to the author "the difference is too marked to be sexual". We do not understand why this character could not be a sexual one. This species (?) is found along the southern coast of Australia, and round the south-west corner of W. Australia as far as Swan River.

Finally Iredale mentions a series of *Mesembrisepia* from north Tasmania "becoming very near to *macandrewi*, but not reaching its size". The width of these shells varies between 31 and 37%, their length between 110 and 150 mm.

We do not know whether the specimens of *Sepia chirotrema* mentioned by Cotton (1929 and 1931) and by Iredale (1954, p. 70) really belong to this species. But it is noteworthy that their relative width varies from 25 to 38%.

Without a thorough study of a great number of animals and shells of different sexes and sizes it is impossible to come to a conclusion but we suppose that all Iredale's species belong to *Sepia novaehollandiae* and we are almost convinced that *Sepia chirotrema* Berry is a completely different species, not even related to the former.

After having completed this text, we had the opportunity to examine five shells from Semaphore, S. Australia (B.M. 1962256W. 1–5) which belong without any doubt to *Sepia novaehollandiae*.

The shells present the following relative measurements:—

No.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
1	?♀	122	36	9·8	75	4·1	pl. 15, figs. 87 & 88
2	?♂	122	31	11	±61	4·9	pl. 15, figs. 89 & 90
3	?♀	112	37·5	10·1	74	3·1	
4	?♂	91	35	11	59	4·4	
5	?♀	86	36	10·5	61	3·5+	

They show two forms which in our opinion represent the two sexes, but more material is needed to substantiate this belief. Numbers 1, 3 and 5, which probably belong to females, are relatively broader and flatter with a longer striated area, which shows a broader, relatively shallower median groove.

The dorsal surface which is more or less rose-coloured, especially in its posterior part, has three longitudinal ribs, more or less well-defined; the width of the median rib varies a good deal. The anterior part is delicately granulous, the posterior part strongly rugose, the granules forming radiating ridges in the median portion. The width of the chitinous margins of the anterior part is variable. The base of the spine forms two thick lateral expansions and is well set off against the rugose posterior portion of the shell. The strong spine, devoid of any keels, is straight in the narrow specimens (♂ ?) and turned upwards in the broader ones (♀ ?), but we do not know if this character is constant. If

our hypothesis is confirmed, the five shells from Adelaide (I.R.S.N.), mentioned in the comparative table (p. 50) are probably males.

The ventral surface shows that the striated area is longer in the broader shells, with a wider median groove and the rounded ribs limiting it are more widely apart. Hence the outline of the striae is different, projecting anteriorly more in the middle, in the narrow shells. The striated area is separated from the outer cone by two narrow smooth zones. The inner cone is completely fused to the outer one, its posterior portion slightly thicker, surrounding a weak depression. In most specimens the outer cone seems to be interrupted between the inner cone and the spine, but in fact it is continuous as a narrow border. The thick base of the spine is hollowed out in the centre and shows a radiating striation.

24. *Sepia acuminata* Smith, 1916.
(Pl. 16, figs. 91 & 92; pl. 43, fig. 261)

Sepia acuminata Smith, 1916, p. 21, pl. II, figs. 3 & 4; Tomlin, 1923, p. 40; Robson, 1924, p. 12; Massy, 1928, p. 91, pl. VIII, figs. 1–7; Turton, 1932, p. 1.
Rhombosepion acuminata, Robson, 1924*a*, p. 643.
Sepia sp. A (pars) Robson, 1924, p. 13.

TYPE LOCALITIES: Port Elizabeth; Tongaat Beach, Natal.
GEOGRAPHICAL DISTRIBUTION: South Africa.
MATERIAL:

a. Port Elizabeth (Ponsonby); B.M. 1890.9.22.332–3; 2 shells (syntypes).
b. Port Elizabeth (Spencer); B.M. 1890.12.14.34; 1 shell.
c. Tongaat Beach, Natal (Burnup); B.M. 1920.3.23.2–4; 3 shells.
d. Natal: Sta. 95, 45 fms.[1] (♀); Sta. 103, 160 fms. (♂) (Mar. Biol. Surv. South Africa, Coll. Gilchrist, det. Robson); B.M. 1924.9.9.72–3; 1 ♂, 1 ♀, 2 shells (one of these shells, which is in rather poor condition, must belong to the ♀; Under the same registered number there is a third dry shell, labelled "*S. acuminata*, juv. No. 109" by Robson; this seems to belong to *Sepia hieronis*, being more elevated, with a distinct median groove and the limbs of the inner cone practically at the base of the outer cone; it has no spine at all and a broad portion of the outer cone surrounds the inner one).
e. Port Elizabeth; B.M. 1952.11.24.1; 1 shell.
f. Isipingo; B.M. 1952.11.24.2; 1 shell.
g. Univ. Cape Town Ecol. Surv., Afr. 1051 K; B.M. 196376W; 1 ♂ (L_M = 78 mm).
? *h*. Mombasa (Coll. Selfe, Kenya); 3 broken shells. B.M. 196377W.

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
d	♀	79	83	53	29	40	89	11	32
	♂	67	78	49	25	36	87	9	25

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
d	♀	79	32	32	35	95	13	1·26	0·38
	♂	67	27	28	33	105	13	1·04	0·37

[1] According to Barnard (*in litt.*) the exact localities are: Sta. 95, 29°52′S., 31°17′ E., 192 fms.; Sta. 103: 29°54′S., 31°15′E.; 160 fms.

Shells (in % of shell-length)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
b	—	109	40	10·1	63	5·5	
a		104	36	9·1	64	6·7	pl. 16, figs. 91 & 92
e	—	104	38	9·6	65	6·7	
c	—	100	38	9·8	70	5·5	
d	—	74	41	9·9	61	—	
f	—	64	44	10·2	58	7·0	
d	♂	63	44	11·1	65	—	
c	—	50	44	10·6	54	6·0	
c	—	31	48	9·7	52	6·4	

Description: The dorsal mantle-margin projects forward; this projection being broadly triangular.

The dorsal arms are externally rounded, the dorso-lateral ones have distinct outer keels and flattened ventral sides, the ventro-lateral ones have stronger outer keels and still flatter ventral sides, while the ventral ones have strong outer swimming-membranes. All the arms possess wide protective membranes. The arm-suckers are quadriserial; the proximal ones have almost smooth chitinous rings and the more distal ones have close-set sharp teeth, especially at the distal margins.

The buccal membrane is connected to the arms by strong attachments. The pouches between the arms and the buccal membrane are particularly wide and deep. There are six of them, one opposite each of the dorsal arms, one opposite the two lateral arms and one opposite each of the ventral ones. The interbrachial web is well developed and is highest between the dorsal arms.

The tentacular stem is triangular in cross-section; it is keeled on the outer side and flattened on the inner one, with two lateral ridges, these being the continuation of the protective membranes of the club. The swimming-membrane is well developed and extends beyond the base of the club for a distance of about half the length of the club. The protective membranes are wide and are separated at the base of the club. The minute, sub-equal, long-stalked suckers are arranged in about 8–10 series. At the distal end of the club there are the two slightly larger suckers we find in most species; these are covered by a thick fleshy flap (pl. 43, fig. 261).

The left ventral arm of the male is hectocotylized. It has about six transverse rows of normal suckers at the base. The transformed portion is narrow and long (6 mm) with about nine series of much smaller suckers. The two ventral longitudinal series are close together and form practically one single series of 18 close-set suckers. These are separated from the dorsal ones by a thick fleshy ridge. The dorsal suckers form two separate series of widely-spaced suckers which are smaller than the ventral ones in the greater part of the hectocotylized portion.

The shell is rhomboidal, broadest in the middle, being acuminate at both ends (pl. 16, figs. 91 & 92). The dorsal surface is salmon-coloured, with a distinct median rib, a faint indication of two lateral ribs and broad chitinous margins.

The ventral surface is flat, the striated zone with a very faint indication of a median and some other linear furrows. The striae are regularly convex in the posterior part and slightly angular near the anterior end. The striated zone is separated from the outer cone by two narrow, nearly-smooth areas. The inner cone has a slightly raised, rounded posterior ridge, surrounding a shallow posterior pit. The lateral limbs are very narrow, situated in the middle of the smooth marginal areas or near the base of the outer cone. The latter is broad, surrounding the whole inner cone and forming a chitinous ledge in its posterior part, with slight radial ribs between the inner cone and the spine. The spine is devoid of keels; it is straight or slightly curved upwards.

Remarks: Among some broken shells from Mombasa (*h*) are three incomplete bones which resemble *Sepia acuminata* very much; their dorsal surface has the same salmon colour, granulation and broad chitinous margins, but instead of the mid-dorsal rib there is a deep narrow groove. As the posterior end is lacking, we cannot describe these shells in detail. Complete specimens are needed before we can decide if these shells really belong to *Sepia acuminata*.

According to Smith (1916, p. 21): "A small specimen, 35 mm in length, described by Dr. G. Pfeffer as *S. venusta* (= *venustoides* Hoyle) from Zanzibar apparently closely resembles the young of this species." As we pointed out on p. 25, Pfeffer's species has a different tentacular club and belongs rather to *Sepia pharaonis*.

Sepia acuminata seems to be closely related to *S. madokai* and to *S. rex* (see p. 56).

25. ***Sepia jaenschi*** (Cotton, 1931)
(Pl. 16, figs. 93 & 94)

Decorisepia jaenschi Cotton, 1931, p. 41, figs. 5 & 6.
Sepia (*Decorisepia*) *jaenschi*, Cotton & Godfrey, 1940, p. 439, fig. 427.

Type locality: Robe, S. Australia.
Geographical distribution: Robe; Port Fairy, Victoria.
Material:

a. Robe, S. Australia (Pres. Cotton); B.M. 1962258W; 1 shell.

Measurements:

Shells (in % of shell-length)

Species	Locality	L. in mm	W.	Th.	Str.z.	Spine	Observations
S. jaenschi	Robe	103·5	36	8·4	—	—	Holotype
,,	,,	112	28·5+	8·3	71	3·6+	Spec. *a*. pl. 16, figs. 93 & 94
S. cottesloensis	Cottesloe	42.6	43	10·5	—	—	Holotype
S. rex	Manly Beach	119	33·5	—	—	—	Holotype
,,	N. Tasmania	50	40	—	—	—	Iredale, 1954, p. 69
,,	,,	90	33·5	—	—	—	,,
,,	,,	111	36	—	—	—	,,
,,	,,	118	34	—	—	—	,,
,,	,,	123	34	—	—	—	,,
,,	E. Victoria	28	46·5	—	—	—	,, , p. 70
,,	,,	54	40·5	—	—	—	,,
,,	,,	57	40·5	—	—	—	,,
,,	,,	64	40·5	—	—	—	,,
,,	,,	76	38	—	—	—	,,
,,	,,	105	37	—	—	—	,,
,,	,,	117	37	—	—	—	,,
,,	,,	124	36·5	—	—	—	,,
,,	Torquay, Victoria	120	38·5	8·7	—	5·4	,, , p. 72
,,	N.S. Wales	127	34	—	—	—	,,
,,	,,	124	38	—	—	—	,,
,,	Capricorn Group	140–150	35·5–33·5	—	—	—	,,

Description: The only specimen we have examined is the shell presented to the British Museum and identified by Cotton (pl. 16, figs. 93 & 94). It is rather damaged and the exact width and the form of the posterior part of the outer cone cannot be properly described. It is in any case much narrower than the holotype. It is elongate oval and strongly acuminate at the anterior end. The dorsal

surface is rose-coloured, with three longitudinal ribs separated by two, narrow, well limited furrows. The median rib is finely granular with the rest of the dorsal surface more coarsely granular, especially in the lateral parts where the granules form longitudinal series in the anterior half of the shell and a more reticulate pattern in the posterior portion. The extreme posterior part, near the spine, is smooth and glossy. The rounded spine is turned upwards.

The ventral surface is rather flat with a narrow, shallow, median groove over its whole length. The striae are slightly convex in the posterior part, more and more reversed V-shaped towards the last loculus. The median groove is flanked by two low ribs. The striated area is separated from the outer cone by two narrow smooth zones. The inner cone has very narrow limbs which form a rounded ridge surrounding the posterior portion of the striated area. In its posterior part and partly on the sides, this ridge overhangs the striated area slightly, leaving a narrow cleft between the former and the latter. From the rounded ridge, which in the anterior part of its limbs separates the striated area from the narrow smooth zones, extends irregularly a flatter part which is completely fused to the outer cone. The latter is much too damaged to be properly described.

Remarks: Without Cotton's identification of this specimen, we should have hesitated to consider it as *Sepia jaenschi* Cotton.

The figure of the holotype, reproduced by Cotton & Godfrey (1940, p. 439, fig. 427) shows a much broader shell, which, according to the text, has no ventral sulcus, although the figure indicates it. According to the diagnosis of *Decorisepia* the inner cone is absent, but on the next page the authors describe it as "obsolete". In fact, the inner cone is narrow but that it exists there is no doubt.

We have never seen the second species described by Cotton: *Decorisepia cottesloensis* (1929, p. 90, pl. XVI, figs. 1 & 2) which has a relatively much broader shell, but as it is also much smaller this is probably a juvenile character. Its general form strongly resembles that of *Sepia rostrata* Férussac & d'Orbigny (1835, pl. 8, fig. 6) (*non* Férussac & d'Orbigny, 1848, p. 284, pl. 26), but the inner cone seems to be quite different.

Iredale (1926, p. 193, pl. XXII, figs. 9 & 10) has described *Decorisepia rex*, the type-species of this genus, which is characterized as lacking the inner cone, from New South Wales. In the original description it is stated that this species has no ventral sulcus, but the figure shows it very clearly. According to Iredale (1954, p. 70) the specimen from Torquay, Victoria (see table of measurements) recorded by Chapman (1912, p. 24, pl. I) as being "*Sepia capensis* d'Orbigny", belongs to *Decorisepia rex*. In his later paper Iredale (1954, p. 72) mentions under *S. rex* that "similar shells have been named *jaenschi* from Western Victoria and South Australia, and another shell from Rottnest Island, Western Australia, *cottesloensis*". It is not clear from his text if he considers these two species as specifically different from *S. rex*. As we have only seen a single shell of *S. jaenschi*, we prefer not to take a final decision, but we are strongly inclined to believe that they all belong to a single species: *S. rex* Iredale, 1926. Garrard (1961, p. 36) mentions two live specimens of the latter species, captured in 76–80 fms. east of Lake Macquarie, but does not describe them.

As to the relations of this latter species with species from other parts of the Indo-Pacific, the shells of *S. acuminata* (pl. 16, fig. 75) and *S. madokai* Adam, 1939 (= *S. robsoni* Sasaki, 1929, *non* Massy, 1927) are very much alike. The former, from S. Africa, shows exactly the same general outline and the same ventral aspect as the holotype of *S. jaenschi*, but the longitudinal ribs of the dorsal surface are somewhat less pronounced than in the above described specimen of that species. As to *S. madokai*, from Japan, we have not examined any material and we can only refer to Sasaki's description and figures (1929, p. 179, pl. XVII, figs. 2 & 3). The figured shell measures 62 × 23·4 mm (W. = 37·5%) and the description does not reveal any character which permits us to distinguish it from *S. jaenschi*.

When compared with Sasaki's description of *S. madokai*, the animal of *S. acuminata* does not

seem to differ from it in any respect. The two species seem to be closely related or may perhaps be identical.

26. *Sepia bertheloti* d'Orbigny, 1838
(Pl. 16, figs. 95–98)

Sepia bertheloti d'Orbigny, 1838, p. 21, pl. II; Férussac & d'Orbigny, 1848, p. 274, pls. 11, 23; Adam, 1941, p. 109, pl. IV, fig. 2; 1951, p. 772; 1952, p. 15, figs. 4–6, pl. I, figs. 3 & 4; 1960*a*, p. 465; 1961, p. 227; 1962, p. 13.
Acanthosepion bertheloti, Rochebrune, 1884, p. 106; Adam, 1944, p. 232.
Sepia verrucosa, Lönnberg, 1896, p. 697 (*non* Bellardi, 1872).
Sepia (*Acanthosepia*) *mercatoris* Adam, 1937, p. 56, figs. 6–10.

TYPE LOCALITIES: Teneriffe, Canary Islands (*S. bertheloti* and *S. verrucosa*), Rufisque (*S. mercatoris*).
GEOGRAPHICAL DISTRIBUTION: West Africa, from Teneriffe to Angola (Tiger Bay).

DESCRIPTION: We have not studied the material of this species in the collections of the British Museum, but as the southern limit of many West African species is not known because of insufficient collecting, we give a short description of *Sepia bertheloti* from Adam's report (1952, p. 15) which was based on 200 specimens.

Until now it has been collected in depths varying between 20 and 156 m and it seems to be more sub-littoral than *Sepia officinalis hierredda* (p. 32).

The mantle is more than twice as long as broad; its dorsal margin projects strongly in a long, sharp angle, while the ventral margin is slightly emarginate. Both males and females have a series of elongate tubercles at the base of the fins and, outside of these tubercles, numerous, small, light-coloured, round patches, which are more pronounced in the males, who have, moreover, a narrow, reddish streak near the free margin of the fins.

The longest male observed, measured 171 mm in dorsal mantle-length and the longest female was 134 mm.

The relative measurements differ much more according to the sexes than in *S. officinalis hierredda*. The mantle is wider in the female while the arms are much longer in the male, especially the ventral ones, which attain more than 50% of the mantle-length. These measurements were all based on preserved animals; according to Rancurel (Abidjan), in a verbal communication to Adam, all the arms in both males and females are much longer in fresh animals and seem to undergo considerable contraction during fixation. All the arms are laterally compressed, keeled on their outer sides. The globular suckers are quadriserial, the median ones having a slightly greater diameter than the lateral ones.

The tentacular club is rather slender; its swimming-membrane does not extend beyond the base, the protective membranes are separated at the base and do not continue down the stem. The unequal tentacular suckers are apparently arranged in five or six series, but in fact they form oblique transverse rows of eight, the third sucker of each row being the largest. The arrangement of these suckers recalls that of *S. officinalis* but those of *S. bertheloti* are not so unequal and are much smaller; they hardly exceed the size of the arm-suckers.

The left ventral arm of the male is hectocotylized in its proximal third, which bears a few normal suckers at its base, followed by 9 to 13 transverse rows of minute, spaced, suckers. The dorsal protective membrane is very broad, almost completely covering the suckers.

The female has a pair of receptacula seminis in the ventral part of its buccal membrane.

The shell is elongate oval, its width measuring 23·5–30·5% in the male, 26–33·5% in the females and has a thickness 8·5–11·5% in both sexes (pl. 16, figs. 95 & 98). The dorsal surface has a median rib and is finely rugose, the tubercles being arranged in longitudinal series in the lateral parts. The

posterior portion is covered by a glaze-like substance which does not cover the strong spine; the latter is devoid of keels. The ventral surface is slightly convex, with a faint median furrow. The striae of the long striated area are convex with a small indentation in the middle.

Even in the small specimens the length of the striated area exceeds half the shell-length and may even attain 70–80% in the longest specimens.

The inner cone has narrow, slightly-rounded limbs, its posterior part being somewhat wider and flattened. The outer cone is continuous behind the inner one.

Young females of a mantle-length of 50 mm are already mature, the size of their eggs does not differ from that of the largest females.

REMARKS: The animals of this species are not easily distinguished from *S. officinalis*, although the ventral arms of the male are much longer and the largest tentacular suckers relatively smaller. But the shell is very characteristic and does not resemble that of any other species.

27. *Sepia cultrata* Hoyle, 1885
(Pl. 17, figs. 99 & 100)

Sepia cultrata Hoyle, 1885, p. 198; 1885*a*, p. 303; 1886, p. 133, pl. XX; Whitelegge, 1889, p. 282; Brazier, 1892, p. 12; Chapman, 1912, p. 25; ? Hedley, 1918, p. M.33.
Sepia capensis var. Gray, 1849, p. 110 (*non* d'Orbigny, 1835).
Glyptosepia cultrata, Iredale, 1926, p. 192, pl. XXII, figs. 5 & 6; 1954, p. 73; Garrard, 1961, p. 36; Iredale & McMichael, 1962, p. 99.
? *Glyptosepia macilenta* Iredale, 1926, p. 192, pl. XXII, figs. 3 & 4; 1954, p. 73; 1955, pp. 78–79.

TYPE LOCALITY: off Twofold Bay, Australia.

GEOGRAPHICAL DISTRIBUTION: New South Wales. Garrard (1961, p. 36) mentions the capture of two live specimens in 156–160 fms. east of Newcastle.

MATERIAL:

a. Challenger Sta. 163 A, off Twofold Bay, Australia, 36°59′S., 150°20′E. 4.Mar.1874, 150 fms., gn. m., B.M. 1889.4.24.75; 1 ♀ (holotype).
b. Sydney (Edwards); B.M.1837.5.13.44. (det. Gray, 1849 as *Sepia capensis* var.); 1 shell.
c. Australia (Sinclair); 1842.11.2.30. (det. Gray, 1849 as *Sepia capensis* var.); 1 shell.

MEASUREMENTS:

ANIMAL (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I.
a	♀	83	87	43	±18	45	87	11	26

Loc.	Sex	M.L.d.	A.L. II	A.L. III	A.L.IV	T.L.	T.cl.	S.a.	S.t.
a	♀	83	25	25	28	97	9·5	1·08	0·6

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	W.	Str.z.	Spine	Observations
a	♀	—	±31	±8·5	—	—	
b	—	85	32	7	71	5·9	pl. 17, figs. 99 & 100
c	—	84	30	7	71	7·7	

DESCRIPTION: The body is elongate-oval, the dorsal mantle-margin projects strongly forward extending to beyond the level of the eye-opening, the ventral margin is slightly emarginate. The arms are laterally compressed and keeled on their outer sides; the suckers are quadriserial and the protective membranes are narrow. A very curious deformation is seen on the left dorso-lateral arm, where, at about one third of the length, both protective membranes are completely fused for a distance of about $1\frac{1}{2}$ mm, covering the suckers. The buccal membrane is expanded on the ventral side.

The tentacular club has a strong swimming-membrane, about $1\frac{1}{2}$ times as long as the club. The dorsal protective membrane is nearly as wide as the sucker-bearing surface and is separated at the base from the ventral membrane. The small sub-equal suckers are arranged in about five longitudinal series, their chitinous rings are finely dentate.

The arm-suckers have small, smooth, chitinous rings, each surrounded by a narrow papillate zone, which is surrounded by a thick fleshy zone with radial grooves, which is emarginate at its distal end.

The shell of the holotype is incomplete and the following description is partly based on the other two specimens, especially as regards the posterior portion. It is elongate, rounded at the anterior end and acuminate at the posterior one, which is terminated by a strong spine with a ventral and a lesser developed dorsal keel. The dorsal surface shows a median rib on both sides of which there is a broad flattened zone with a few longitudinal grooves; these zones are separated from the less granulous marginal areas by a more or less angular lateral rib. In the posterior portion a calcareous ridge separates these marginal areas from the dorsal part of the outer cone which is covered by elongate, anastomosing, calcareous tubercles. In the anterior portion the chitinous margins are wider than in the posterior one. The ventral surface is faintly convex and nearly flat in its posterior part, with a very shallow and narrow median groove over the whole length and two wide and shallow marginal grooves. On both sides of the striated zone, the striae of which are very little convex, there is a narrow smooth area which is slightly concave. The inner cone is narrow and its limbs are fused to the outer cone; its posterior part slightly raised as a small sharp ledge, surrounding the posterior depression and is itself surrounded by a ledge formed by the outer cone.

REMARKS: Hoyle (1886, p. 136) mentions that according to Smith *Sepia cultrata* "may be the same species (although a *var.*) that Gray has identified in the museum collection as *Sepia capensis*, but which seems to me distinct from *Sepia capensis* of d'Orbigny (= *Sepia australis* Quoy and Gaimard)".

According to Iredale (1955, pp. 78–79), the original drawing of the type was not correct. "The type bone did not essentially disagree with the variety and both are undoubtedly the local shell which I named *macilenta*, so that *cultrata* can be reinstated, and *macilenta* dropped as a synonym of *Glyptosepia cultrata*."

The specimens we have examined and described agree with Iredale's figures (1926, pl. XXII, figs. 5 & 6) of "*Glyptosepia cultrata*" which he copied from the original figures as he had "been unable to find a specimen in agreement, even after suggesting that both description and figure are incomplete or imperfect" (1926, p. 193).

The original figures of *Glyptosepia macilenta* Iredale (1926, p. 192, pl. XXII, figs. 3 & 4) represent an entirely different species, which cannot be considered to be identical with *Sepia cultrata*.

Iredale (1926, p. 191) created the genus *Glyptosepia* for a group of bones which "differ at sight in their colouration, but the marked feature is the loss of the inner cone, a feature of great significance, while the shape of the bone differs and the spine is very long and strongly keeled".

Moreover "there is no ventral sulcus, though the ventral surface is a little swollen anteriorly and the striated area is generally long".

Notwithstanding these statements, the figures of the different species described by Iredale (1926,

pl. XXII, figs. 1–8) show a ventral sulcus and an inner cone. According to the original descriptions these species possess a ventrally keeled spine, whereas *Sepia cultrata* has a dorsal and a ventral keel on its spine.

Unfortunately we have not had the opportunity to examine Iredale's species of *Glyptosepia: G. opipara* (1926, p. 191, pl. XXII, figs. 7 & 8; 1954, p. 72), G. *gemellus* (1926, p. 192, pl. XXII, figs. 1 and 2; 1954, p. 73), and *G. macilenta* (1926, p. 192, pl. XXII, figs. 3 and 4; 1954, p. 73).

Verco & Cotton (1928, p. 127) were the first authors to consider *Sepia hedleyi* Berry, 1918, as a *Glyptosepia*. In the original publication, Berry (1918, p. 261, pl. LXXII, fig. 2) gave a reconstruction of the shell, which was "absent or fragmentary in all specimens seen". This shell resembles that of *Sepia cultrata*, but the tentacular club is different, the minute suckers being arranged in 12 series.

We are not sure that the shell figured by Cotton & Godfrey (1940, p. 437, fig. 424) really belongs to *Sepia hedleyi* Berry.

According to Iredale (1954, p. 74) the species which Cotton (1929, p. 87, pl. XV, figs, 1 & 2) described as *Solitosepia hendryae*, would be best referred to *Glyptosepia*, because it lacks the characteristic inner cone of *Solitosepia* and its anterior end is formed in the style of that of *Glyptosepia*. But in the original description of *Sepia hendryae* the inner cone is described as being "prominent aborally, becoming indistinct orally", whereas according to Iredale (1926, p. 191) "there is no inner cone apparent" in *Glystosepia*. Moreover, *Sepia hendryae* has a deep median ventral sulcus, which is absent (?) in *Glyptosepia*.

According to Chapman (1912, p. 25):—

> "The *Sepia mestus* Gray, which is recorded by Tate and May from the north coast of Tasmania, is a broad form of *S. cultrata* Steenstrup. It might easily be confused with the young stage of *S. apama* Gray, except that the latter has a thicker shell above the median area, and the growth lines are convex and not sinuous, whilst the mucro of *S. cultrata* and its varieties is keeled on the ventral face."

In our opinion, there is not the slightest resemblance between *Sepia mestus* and *S. cultrata* (see p. 47).

Iredale (1926*a*, p. 238) states that the species recorded by Hedley (1918, p. M.33) as *S. cultrata* is in fact *Solitosepia plangon adhaesa*, Iredale 1926.

28. ***Sepia appellöfi*** Wülker, 1910
(Pl. 17, figs. 101 & 103; pl. 43, fig. 259)

Sepia appellöfi Wülker, 1910, p. 14, figs. 8, 15–18; Sasaki, 1920, p. 193; 1929, p. 184, pl. XVII, figs. 10–12, text-fig. 106.
Sepia (*Doratosepion*) *appellöfi*, Berry, 1912, p. 424; Sasaki, 1914, p. 618.

TYPE LOCALITY: Misaki, Japan.
GEOGRAPHICAL DISTRIBUTION: Japan.
MATERIAL:

a Sagami, Japan (Pres. Ridewood); B.M.1910.9.29.1; 1 ♀.

MEASUREMENTS:

ANIMAL (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a	♀	90	82	53	20	27	—	—	42

Loc.	Sex	M.L.d.	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	♀	90	42	42	44	145	15	1·1	0·45

SHELL (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
a	♀	90	27	11·5	53	4·5	pl. 17, figs. 101–103

DESCRIPTION: The mantle forms a pronounced mid-dorsal anterior projection. The fins are very narrow and begin about 5 mm behind the mantle-margin. The funnel is very long, its tip reaching the anterior level of the eyes.

All the arms, except the ventral ones, have very slender tips with the suckers arranged in two series. On the ventral arms the suckers are quadriserial along the whole length; on the proximal part of the other arms they are also in four series. According to Sasaki (1929, p. 185) the left ventral arm of the male is hectocotylized in the distal third. The suckers are normal up to the twelfth row while on the remaining distal part they are rudimentary.

The tentacular club is short, oval, covered with minute long-stalked suckers which seem to be arranged in at least eight longitudinal series (pl. 43, fig. 259). These suckers are sub-equal and do not show any larger suckers on the dorsal side. The sucker-less marginal part of the dorsal protective membrane is rather broad.

The shell is elongate, rounded at its anterior margin, and broadest in its anterior third, it is acuminate posteriorly with a strong, straight spine, devoid of keels (pl. 17, figs. 101–103). The dorsal surface shows a distinct median rib and broad chitinous margins; the central part is coarsely granulous, the granules being arranged in longitudinal series in the lateral portions of the posterior half, with a distinct ridge on both sides of the calcareous part. The posterior half of the shell is regularly curved. The ventral surface is concave in the posterior part of the striated area but strongly convex in the anterior third of the shell. The striated area shows a faint, narrow, median groove; the striae are regularly convex in the posterior part and are more wavy in the anterior portion where they are convex on both sides of the median groove. The inner cone forms a regularly-rounded ridge, its posterior part surrounding the posterior excavation; its lateral limbs are situated at the margins of the striated area which is separated from the outer cone by two distinct, smooth zones. The outer cone is narrow, chitinous in its lateral parts and calcareous in its slightly expanded posterior part, which forms two wings surrounding the inner cone.

REMARKS: This species differs from *S. kobiensis* in its tentacular club and its broader shell, the inner cone of which does not possess the elongate posterior ledge.

The shell of *S. appellöfi* resembles that of *S. murrayi* (p. 64) in its general shape, but it is relatively broader, with broader chitinous margins on the dorsal surface and a coarser sculpture. The tentacular club of the latter has only five series of minute, sub-equal suckers and a broader dorsal protective membrane. The hectocotylus of *S. murrayi* is unknown.

29. ***Sepia sewelli*** sp. nov.
(Pl. 17, figs. 104–106; pl. 46, fig. 273)

MATERIAL:

Holotype:

a. John Murray Exp. Sta. 27, 11°57′12″N., 50°35′00″ E. to 11°56′42″N., 50°39′12″E., near Cape Guardafui, 37 m, 12.x.1933; 1 ♀. B.M. 196378W.

Paratypes:

b. John Murray Exp. Sta. 105, 5°34′24″S., 39°14′06″E. to 5°37′00″S., 39°14′36″E., Zanzibar area, 238 m, 11.i.1934; 1 ♀ (in poor condition), B.M. 196379W.

c. John Murray Exp. Sta. 106, 5°38′54″S., 39°15′42″E. to 5°40′18″S., 39°17′36″E., Zanzibar area, 212 m, 12.i.1934: 17 young specimens (in poor condition). B.M. 196380W.

MEASUREMENTS:

ANIMAL (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a.	♀	24	98	56	33	52	—	8	35

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	♀	24	35	35	35	—	14·5	—	—

SHELL (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
c	—	31	26	9·7	54	7·4	pl. 17, figs. 104–106

DESCRIPTION: The dorsal mantle-margin projects forward slightly and the ventral one is emarginate. The fins are widely separated posteriorly. The web is low, being highest between the dorso-lateral and ventro-lateral arms and between the ventro-lateral and ventral ones.

The suckers are quadriserial, the median ones being slightly bigger than the lateral ones.

The swimming-membrane of the tentacular club is slightly longer than the club. The dorsal protective membrane is rather broad. The minute, sub-equal suckers are arranged in about six to eight longitudinal series (pl. 46, fig. 273).

The shell is elongate with a well developed median rib flanked by two shallow grooves on the dorsal surface. The granulous calcareous part is limited by two narrow calcareous ridges (pl. 17, figs. 104–106).

The ventral surface is slightly raised with a narrow, shallow groove over its whole length. The striated area has convex striae which are slightly emarginate in the middle; it is flanked by two smoother, slightly concave marginal zones. The narrow limbs of the inner cone are situated between the striated area and the marginal zones. its posterior part forms a slightly larger, rounded posterior ledge.

The wings of the outer cone constitute a cup-like formation.

The spine is straight, directed upwards; its dorsal margin is convex and it is devoid of keels.

REMARKS: This species differs from *Sepia kobiensis* (p. 71) in the different arrangement of the tentacular suckers, the flatter shell, the absence of the longitudinal striae on its dorsal calcareous surface and in the less developed posterior portion of the inner cone.

Compared with *S. murrayi*, the tentacular club of *S. sewelli* has a greater number of longitudinal series of suckers. The shell of *S. sewelli* is slightly wider and thicker in its anterior part. The dorsal surface has its granulous covering limited by a distinct marginal ridge, whereas in *S. murrayi* the granules constitute several marginal lines. In *S. sewelli* the ventral median groove is wider, the outline of the striae distinctly different, being reversed V-shaped in the anterior part of the striated area. It

will be noted that this outline is reversed W-shaped in *S. murrayi*. The posterior part of the inner cone forms a rounded ledge in *S. sewelli* and a more angular sharp ledge with radiating calcareous keels in *S. murrayi*.

In *Sepia appellöfi* the shell has about the same general outline as that of *S. sewelli*, but the shell of the former species is thicker, its dorsal surface more coarsely granular, the granules mostly arranged in longitudinal series on the posterior part (limited also by a marginal calcareous ridge) and the chitinous margins are much wider; the outline of the striae in the anterior part of the striated area is also different, being reversed W-shaped as in *S. murrayi*. The arrangement of the tentacular suckers of *S. appellöfi* is approximately the same as in *S. sewelli*; unfortunately the hectocotylus of the latter is unknown.

30. ***Sepia murrayi*** sp. nov.
(Pl. 18, figs. 107–111; pl. 43, fig. 260)

Holotype: John Murray Exp. Sta. 71, 25°35′00″N., 56°42′18″E. to 25°43′00″N., 56°39′18″E., Gulf of Oman, 106 m, 26.xi.1933; 1 ♀ (M.L.d. = 40 mm). B.M. 196381W.

Paratypes: Idem; 2 ♀. B.M. 196382–3W.

Measurements:

Animals (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
	♀	40	85	40	20	39	80	10	30
	♀	40	85	39	20	40	83	12·5	30
	♀	41	90	41	22	39	90	10	32

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
	♀	40	32	32	32	112	10	1·0	0·6
	♀	40	30	30	32	95	10	1·0	0·6
	♀	41	32	32	34	110	10	1·0	0·6

Shell (in % of shell-length)

Loc.	Sex	L.in mm	W.	Th.	Str.z.	Spine	Observations
	♀	40	22·5	7·5	55	6·2	Holotype, pl. 18, figs. 107–109

Description: The body is elongate-oval, acuminate behind and with an angular but not very long dorsal mantle-margin, reaching the mid-level of the eyes; the ventral margin distinctly emarginate around the funnel. The head is as wide as the mantle. The fins begin at a short distance behind the mantle-margin; they are rather broad in well preserved specimens, their posterior borders extending beyond the end of the mantle, coming very close together without fusing and leaving a small notch at the base of the spine (pl. 18, figs. 110 & 111).

All the arms are laterally compressed with distinct, but low, swimming-membranes, even on the dorsal ones; this membrane is more developed on the ventral arms.

The distal ends of the arms are not effilated but are bluntly pointed; at these tips the protective membranes are wider and folded over the inner arm surface, more or less covering the suckers. On

the dorsal arms all the suckers are biserial. On the dorso-lateral arms there may be some doubt as to the interpretation of the arrangement of the suckers but they also seem to be biserial. Near the tip these suckers are minute and distinctly biserial, leaving a wide space between them; this arrangement is faintly visible on the right dorsal arm. The same arrangement is seen in all the other arms. These biserial suckers are best seen in one of the paratypes (L_M = 40 mm) but in the other specimens most of the arms show alternate pairs of suckers which may be interpreted as oblique rows of four, but on all the arm-tips the arrangement is distinctly biserial. The chitinous rings of the arm-suckers are smooth.

The tentacles are long and slender, the stem being triangular in cross-section. The short and narrow club is crescent-shaped with a strong swimming-membrane on the dorsal side, extending slightly beyond the base of the club (pl. 43, fig. 260). The dorsal protective membrane is very broad being nearly as wide as the sucker-bearing surface. Both protective membranes remain widely separated at the base of the club and extend down the stem as faint ridges. The minute, sub-equal suckers are arranged in five longitudinal series; their chitinous rings are finely dentate. The web is sub-equal and very low in all sectors.

The shell is very slender and is widest in its anterior third; its posterior part is strongly curved (pl. 18, figs. 107–109). The dorsal surface shows a distinct median rib, flanked by two shallow grooves. In the anterior half the chitinous margins are wide. The whole calcareous part is coarsely granular, these granules forming longitudinal lines at the margins of the posterior part. The ventral surface is rather flat, with a deep narrow median groove over its whole length. On both sides of this groove the surface is regularly convex, except in the posterior part of the striated area, which is flatter. In the anterior portion of the striated area the striae have a reversed W-shape. On both sides of the striated area there is a narrow smooth zone. The limbs of the inner cone are situated on the margins of the striated area and descend slightly on the smooth zones at about half the length of the striated area. At the posterior end these limbs form a V-shaped, straight, sharp ledge which surrounds the posterior excavation. From this ledge radiate narrow sharp keels towards the calcareous posterior shallow cup formed by the small expansion of the outer cone. The straight spine is directed upwards and is devoid of any keels.

Remarks and relationship: Unfortunately the material we had at our disposal consists only of female specimens, so that we cannot describe the hectocotylus.

After having discussed (p. 74) several of the species possessing a slender curved shell with a distinct spine, we arrive at the conclusion that it is in some cases nearly impossible to identify or distinguish these species without knowing the animals, both male and female.

The peculiar arrangement of the suckers on the arm-tips of this new species does not seem to exist in any other species, except in *S. trygonina* (p. 85). The tentacular club resembles that of *S. kobiensis* in the broad dorsal protective membrane, but it lacks the larger suckers of the second row.

The shell shows several differences: the dorsal sculpture with the longitudinal lines of tubercles being much more pronounced in the latter species. The outline of the striae is distinctly different due to the deeper median groove in *S. murrayi*. The inner cone does not show the long ventral ledge seen in *S. kobiensis* and this species lacks the radiating keels between the inner and the outer cone. The shell of *S. murrayi* more nearly resembles that of *S. burnupi* (p. 82) and of *S. trygonina* (p. 85), but the relative importance of the striated area and the two marginal zones is definitely different, the limbs of the inner cone being much more divergent in *S. murrayi* and with sharper edges of the raised posterior part. The inner cone is exactly of the same structure and general form as in *S. omani* (p. 94); in *S. murrayi* the posterior ledge is only slightly more raised and sharp-edged, but *S. omani* has a keeled spine and a completely different animal.

On p. 61 we pointed out the differences between *S. murrayi* and *S. appellöfi*.

The shell of *S. murrayi* resembles that of *S. tokioensis* Ortmann, 1888 (p. 653, pl. XXIII, fig. 3) and of *S. misakiensis* Wülker, 1910 (p. 15, figs. 5, 6, 19–22) but it is flatter and the animal is quite different from these.

As we mention on p. 73, the shell from Poeloe Weh which Adam (1939*c*, p. 38, pl. I, fig. 6) identified as *S. andreanoides*, probably belongs to *S. murrayi*.

Two shells from Santubong and Buntal, Sarawak (Coll. E. Bartleblat) B.M. 1894.7.14.11–12), may belong to *S. murrayi*.

31. ***Sepia confusa*** Smith, 1916
(Pl. 18, figs. 112 & 113; pl. 42, fig. 248)

Sepia burnupi Hoyle, 1904 (pars), p. 27, pl. I, fig. 192.
Sepia confusa Smith, 1916, p. 24, pl. II, figs. 7 & 8; Tomlin, 1923, p. 41; Robson, 1924, p. 12; Turton, 1932, p. 1.
Doratosepion confusa, Massy & Robson, 1923, p. 435, figs. 1–3.
Doratosepion confusum, Robson, 1924*a*, p. 647.
Sepia (*Doratosepion*) *confusa*, Massy, 1925, p. 221, pl. XIII, figs. 20, 21, 24–28, pl. XIV, fig. 38; 1928, p. 93.

TYPE LOCALITIES: Tongaat Beach, Natal; Port Elizabeth, Cape Colony.

GEOGRAPHICAL DISTRIBUTION: South Africa.

MATERIAL:

a. Tongaat Beach, Natal (Burnup); B.M. 1920.3.23.1; 1 shell (holotype, figured by Smith, 1916, pl. II, figs. 7 & 8).
b. Port Elizabeth, Cape Colony (Spencer); B.M. 1890.12.14.42; 1 shell (fragment of 80 mm).
c. Natal Coast (Gilchrist, Sta. 95), 192 fms.; B.M. 1924.9.9.43–44; 2 ♂ and fragments of their shells (Robson, 1924, p. 647).
d. Natal Coast (Gilchrist, Sta. 102), 158 fms.; B.M. 1924.9.9.46–47; 2 ♀ and fragments of their shells (Robson, 1924, p. 647).
e. Natal Coast (Gilchrist, Sta. 107), 180 fms.; B.M.1924.9.9.48; 1 ♂ (Robson, 1924, p. 647).
f. Natal Coast (Gilchrist, Sta. 167), 36 fms.; B.M. 1924.9.9.45; 1 ♀ and fragment of shell (Robson, 1924, p. 647).
g. John Murray Exp. Sta. 106, 5°38′54″S., 39°15′42″E. to 5°40′18″S., 39°17′36″E., Zanzibar area, 212 m, 12.i.1934; 1 ♀. B.M. 196384W.

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
c	♂	±105	71	36	24	27	—	12·5	35
e	♂	±100	70	35	25	28	—	13	35
c	♂	90	72	38	22	32	—	14·5	33
d	♀	85	79	33	23	33	79	13	33
g	♀	84	81	33	18	33	80	8·5	30
f	♀	80	75	35	19	30	81	12·5	34
d	♀	77	80	36	22	31	87	13	38

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
c	♂	±105	29	29	31	85	13	1·5	1·4
e	♂	±100	30	28	30	90	14	1·2	1·8
c	♂	90	28	28	28	—	—	1·7	—
d	♀	85	32	32	33	82	14	1·8	1·2
g	♀	84	32	32	34	—	—	1·5	—
f	♀	80	35	32	35	—	—	1·9	—
d	♀	77	34	34	36	—	13·5	1·7	1·2

SHELL (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
g	♀	84	19	9	±62	4·8	pl. 18, figs. 112 & 113

DESCRIPTION: The body is elongate with rather broad fins; the dorsal mantle-margin is very long and acuminate, reaching the mid-level of the eyes and the ventral margin is slightly emarginate. The dorsal mantle surface shows two blunt ribs or ridges beginning at the anterior end of the fins and converging obliquely to about 2·5 cm from the posterior end of the mantle.

The males show the peculiar tail-like formation of the fins described by Massy & Robson (1923, p. 435). At the posterior end the fins are fused in a single band-like broad tail the length of which may even exceed the length of the mantle. The true function of this secondary sexual character is unknown.

All the arms are laterally compressed and keeled on their outer sides, the ventro-lateral and ventral ones possessing distinct swimming-membranes. In the male, the globular arm-suckers are quadriserial, the median ones being twice as wide as the lateral ones on the basal two-thirds of each arm; they become gradually sub-equal at the distal ends. The left ventral arm of the male does not show any transformation, but the protective membranes, especially the dorsal one, are slightly wider in the distal third of the arm. The chitinous rings of the arm-suckers are smooth. In the female the suckers of the distal ends of the arms become minute and biserial with a wide space between them; at the extreme tip the protective membranes are folded inwards and cover the sucker-bearing surface.

The tentacular club has a well-developed swimming-membrane, which extends slightly beyond the base of the club (pl. 42, fig. 248). The protective membranes are narrow and separated at the base of the club. The suckers seem to be arranged in five or six series, but in fact they constitute very oblique transverse series of eight. About six suckers from the third longitudinal series, situated in the middle of the sucker-bearing surface, are much bigger than the other ones.

The chitinous rings of the tentacular suckers are finely dentate.

The type shell has its dorsal surface rounded with a median rib and two grooves. In the anterior portion only the rib is calcified; in the posterior part the calcified area is broader with distinct longitudinal ridges but anteriorly these ridges are restricted to the median rib as fine fillets of tubercles. The calcareous portion is orange-coloured. The ventral surface is convex with a narrow median groove along its whole length; the striae are convex on both sides of this groove. There is a very narrow smooth zone on both sides between the striated area and the outer cone. The limbs of the inner cone are situated at the margins of the striated area; they disappear near the middle of the latter.

The shell of the female specimen from the John Murray Expedition is the only complete one we have seen (pl. 18, figs. 112 & 113). It is acuminate at both ends. The dorsal surface is rounded with a narrow median rib flanked by two deep grooves. In its anterior portion only the rib is calcified and granulous while in the posterior part a small area next to the rib is calcified; the latter shows some longitudinal calcified ridges, especially in its posterior part. The ventral surface is convex

anteriorly and flattened near the posterior end. There is a narrow, shallow, median groove over the whole length. In its anterior portion the striae are reversed W-shaped, and concave in the middle. The striated area is limited by the narrow limbs of the inner cone, without any smooth marginal zones. In the posterior part the inner cone forms a rather high, sharp-edged ledge, the extreme portion of which is somewhat wider, thicker and rounded, surrounding the posterior excavation; from this semi-circular ledge many fine keels radiate on the calcareous semi-circular expansion of the outer cone. The spine is constricted at the base, widest in the middle, slightly directed upwards and without any keels.

REMARKS: As we state on p. 82, Smith (1916, p. 24) was perfectly right to separate this species from *S. burnupi*.

According to Robson (1924*a*, p. 648) it "shows marked affinities, as far as concerns the only common structure known (the shell), with *D. burnupi* and *insignis*".

In our opinion there is hardly a single character in which *S. confusa* and *S. insignis* are related, the latter species cannot even be placed in *Doratosepion* if one wishes to accept this genus or subgenus (see p. 114, pl. 31, figs. 189–191).

The shell of *S. confusa* seems to be very much like that of *S. pardalis* Sasaki, 1914 (p. 614, pl. XII, figs. 1–3), but the animal, especially the male, is quite different.

This latter, Japanese, species was based on two male specimens of about 230 mm mantle-length. The dorsal mantle-margin is long and tongue-shaped. The arms are relatively short, the dorsal ones being longest and more or less whip-like. The suckers are quadriserial at the base of the arms, biserial on the distal half of the dorsal arms and on the distal third of the lateral ones. On the proximal two-thirds of the left ventral arm there are about 17 transverse rows of normal suckers, whereas the distal third bears only rudimentary suckers. The minute sub-equal tentacular suckers are arranged in eight series.

The shell is slender, lanceolate, more than five times as long as broad, broadest in front of the middle and terminates in a small discoidal outer cone. Its dorsal surface is strongly convex, with a distinct median ridge, marked off by two deep grooves. The surface is coarsely granulous, the granules being arranged in longitudinal lines, slightly diverging from the posterior end. The ventral surface is slightly concave in its posterior part and markedly convex in the anterior, with an irregularly excavated median groove, with the "striated area marked with numerous longitudinal streaks, its anterior border indented in two places". The rim of the inner cone is comparatively broad, but flattened into an only slightly elevated V-shaped ridge at the posterior end. The spine was broken.

32. ***Sepia incerta*** Smith, 1916
(Pl. 19, figs. 114 & 115; pl. 41, fig. 241)

Sepia burnupi Hoyle, 1904 (pars), p. 27, pl. I, figs. 190 & 191.
Sepia incerta Smith, 1916, p. 23, pl. II, fig. 6; ? Tomlin, 1923, p. 41; ? Turton, 1932, p. 1.
Sepia (*Doratosepion*) *burnupi*, Massy, 1925, p. 215, pl. XII; 1928, p. 94; Barnard, 1962, p. 252, fig. 4.

TYPE LOCALITIES: Tongaat Beach, Natal; Port Elizabeth, Cape Province.
GEOGRAPHICAL DISTRIBUTION: South Africa.
MATERIAL:

a. Port Elizabeth (Spencer); B.M. 1890.12.14.43–44; 2 fragments of shells (syntypes).
b. Isipingo (Falcon); B.M. 1952.12.30.71; 1 fragment of shell.
c. Durban; B.M. 1952.12.30.75–76; 2 fragments of shells.
d. Durban (Pres. Chubb); B.M. 196385W; 2 ♂.

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
d	♂	135	67	37	27	24	—	11	81
	♂	140	74	34	21	25	—	11	84

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
d	♂	135	37	38	59	96	15	1·5	3·1
	♂	140	39	39	63	86	14	1·6	2·9

DESCRIPTION: Both male animals have a long conical body with broad fins beginning nearly at the mantle-margin and extending beyond the posterior end of the body; their bases fused on the dorsal surface at about 7 mm from the end of the mantle. The dorsal mantle-margin projects forward strongly and the ventral margin is largely emarginate.

The dorsal surface shows a series of slightly elevated, round, dark spots, situated about in the middle of each fin. Parallel to these there is a series of elongate tubercles at the base of each fin. The rest of the dorsal surface shows numerous small tubercles and at a distance of about 2 cm from the margin of the fins there is a rounded ridge which extends from the mantle-margin to about 2·5 cm from the end of the body.

The dorsal arms are slightly angular on their outer sides. The basal portion shows the following structure over a length of about 25 mm: at the base there are four groups of four suckers placed in alternate pairs, the marginal suckers being smaller than the median ones; beyond these the protective membranes are wider with about seven, spaced, transverse ridges which alternate, each ridge uniting the inner margin of a membrane to the outer margin of the opposite membrane. In the middle of the arm these ridges are separated by deep depressions. Each ridge bears two small suckers, an inner one at the base of one protective membrane and its smaller partner on the outer margin of the opposite membrane. Beyond this basal portion the arms are devoid of suckers. The protective membranes, especially the ventral ones become very wide and thin, attaining a width of nearly 20 mm at the beginning of the distal third of the arm length. These membranes consist of thick, narrow, fleshy ribs separated by very thin membraneous parts which are partly torn. In their widest part the two membranes are fused on about one third of the width of the ventral membrane. At the effilated tips the ribs and membranes disappear.

The dorso-lateral arms are keeled on their ventral outer margins: their suckers are quadriserial throughout the whole length of the arms, the inner suckers being larger than the outer ones.

The ventro-lateral arms have distinct ventral swimming-membranes and the same arrangement of the suckers.

On both ventral arms, which possess strong swimming-membranes, the suckers are normally arranged on the basal halves. Beyond these, the dorsal protective membrane is wider, the suckers much smaller, more and more biserial on the right arm and close together in the median part of it, finally they disappear completely. On the left ventral arm the suckers remain quadriserial almost to the tip, the outer suckers being very minute; there is one series on the middle of each protective membrane, situated on thick fleshy transverse ridges.

The tentacular club (pl. 41, fig. 241) is very much like that of *S. prashadi* (pl. 41, figs. 245 and 246). The swimming-membrane is slightly longer than the club, the dorsal protective membrane being nearly completely separated from the club by a deep groove. Both protective membranes come very

close together at the base of the club but remain separated and continue down the stem as rounded ridges. The suckers are arranged in very oblique transverse series of eight. The first, dorsal sucker is small, the second is one and a half times as big, the third is more than twice as wide as the second and the fourth is intermediate in size between the first and the second, the four last ones being about the size of the first. This arrangement is seen in the first four or five transverse rows, particularly in the second to the fourth. The distal part of the club bears only small suckers. The smaller suckers have finely dentate chitinous rings.

In the large specimen both ventral arms are exactly of the same type as the left one described above for the smaller male. The dorsal arms of this specimen have the same transformation as the one described above, but it begins nearer the base, and the holes are absent, these probably being artefacts due to the thin membranes being torn.

Unfortunately the shells of both specimens are very broken and cannot be extracted for description.

The type shells are very long and slender, but incomplete (pl. 19, figs. 114 & 115). Their dorsal surface shows three calcareous ribs, separated by two narrow grooves that are particularly developed in the posterior half, where the ribs have about the same width. Near the anterior end the lateral ribs diminish gradually in width and finally disappear. The ribs are coarsely granular and salmon-coloured in colour. The chitinous margins are broad. The ventral surface is not very high; it is convex in its greater part and has a shallow and narrow median groove which is somewhat wider on the last loculus. The striated area is convex, the outline of the striae being reversed V-shaped—quite distinct from that in *S. confusa*. The striated area is flanked by two nearly smooth marginal zones. The narrow limbs of the inner cone are situated at the margins of the striated area or descend on the smooth zones. The posterior part of the shell is lacking.

Remarks: Up to the present only the male of this species is known. The female specimens described by Massy (1925, p. 219) belong in fact to *S. burnupi* as we explained on p. 82.

Barnard (1962, p. 252) mentions six specimens from the East London area (33°4′S., 27°54′E., 27 fms.) as belonging to "*Sepia burnupi*". Four of these were males which belong without any doubt to *Sepia incerta*. The author does not state if the other specimens were females and he does not describe them, which is a pity because the female of *S. incerta* has never been described. The arms seem to be longer in Barnard's specimens: in the largest male, of 143 mm mantle-length the dorsal arms are two and a half times, and the ventral arms nearly twice as long as the lateral ones. The description of the modified dorsal arms agrees with our material. As to the ventral arms, the author states that no modification could be recognized as a hectocotylus: "The suckers decrease regularly and gradually in size throughout the whole length of the arm, and on the distal quarter are gradually reduced to 3 in a row, then to 2 and finally to a single row extending to the tip."

Sepia incerta seems to be very closely related to *S. lorigera* Wülker, 1910, of which Sasaki (1929, p. 189) has described both males and females. The dorsal arms of the male of the latter species are much longer, attaining about twice the length of the mantle. Their tips are "markedly thickened, bordered by broad, trabeculate, protective membranes" (Sasaki, 1929, p. 191). The shell is also very similar but seems to be comparatively broader in *S. lorigera*, with a different outline of the striae. As we have only examined incomplete shells of *S. incerta* and as we have not seen any specimens of *S. lorigera*, we do not wish to make any final statement, but we would not be surprised if the differences between these two species turned out to be only of a sub-specific importance, perhaps even due only, as regards the relative lengths of the arms, to the state of preservation.

Sasaki (1914, p. 619; 1929, p. 188, pl. XVII, fig. 13) has described a related species, *S. longipes*, which differs (p. 189) from *S. lorigera* "in the broader body, in the longer arms, in the carinated shell, and in that the hectocotylization affects both the arms of the ventral pair".[1] In *S. lorigera*

[1] On p. 188 the author states that both dorsal arms are affected by hectocotylization, but it is clear that he means the ventral arms.

the distal third of the left ventral arm is hectocotylized, "bearing minute rudimentary suckers, the peduncular bases of which are characteristically swollen into transverse ridges"; in *S. longipes* the distal two-fifths of the left ventral arm "is furrowed longitudinally and has rudimentary suckers in four series. On the proximal three-fifths are found twelve transverse rows of normal suckers".

The right ventral arm is less transformed "and the rudimentary suckers, which are less reduced in size than those of the left arm, are confined beyond the fourteenth row".

In both these Japanese species the tentacular suckers are apparently in longitudinal series of four, but are in fact arranged in oblique transverse series of eight, the four in the middle being much larger.

33. ***Sepia joubini*** Massy, 1927
(Pl. 43, fig. 257)

Sepia (*Doratosepion*) *joubini* Massy, 1927, p. 161, pl. XVIII.

TYPE LOCALITIES: Tugela River mouth, Cape Natal.
GEOGRAPHICAL DISTRIBUTION: South Africa.
MATERIAL:

a. Tugela River mouth, N.W. by N.$\frac{3}{4}$ N.15$\frac{1}{2}$ miles (P.F.11,741, No. 1252), 36–42 fms., m.; B.M. 1926.10.20.38; 1 ♀ (syntype).

b. Cape Natal, W. by N.6$\frac{1}{2}$ miles (P.F.10,715, No. 1262), 54 fms., fine sand and algae; B.M. 1926.10.20.39–40; 1 ♂, 1 ♀ (syntypes).

MEASUREMENTS:

ANIMAL (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a	♀	47	83	32	25	30	85	8·5	30

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	♀	47	38	38	—	72	9·5	1·05	1·3

DESCRIPTION: The female specimen from Tugela River mouth is elongate, cylindrical in its greater part and bluntly rounded posteriorly. The dorsal mantle-margin projects forward in a sharp angle, beyond the mid-level of the eyes; the ventral margin is emarginate in the middle. The rather broad fins begin shortly behind the mantle-margin and extend beyond the posterior end of the mantle, coming very close together on the dorsal surface without being fused. There is a series of three or four widely-spaced, elongate, tubercles on the dorsal base of the fins and just median to them there is a narrow fleshy ridge, beginning at the anterior end of the fins and converging towards the posterior end of the body where they come close together at about 5 mm from the end.

The suckers of all the arms are very obliquely quadriserial, the median ones being wider than the marginal ones. Here and there they seem to be biserial, which is not the case. At the tip of the dorsal arms they remain quadriserial, with a space in the middle, covered by the wide protective membranes. The lateral arms are very narrow and whip-like in their distal half[1] with minute biserial suckers,

[1] According to Barnard (*in litt.*) the whip-like tips of the lateral arms in the ♀ begin to develop from about 30 mm mantle-length. The whip becomes longer relative to the proximal portion, and may become a little longer than the latter.

separated by a smooth and hollowed out empty space; the protective membranes are very narrow. The ventral arms are incomplete. Those of the female specimen from Cape Natal are normal with quadriserial suckers. The ventral and dorsal arms are sub-equal in length, the lateral ones slightly longer.

The male specimen from Cape Natal has sub-equal arms without the whip-like transformation of the lateral ones, their suckers are quadriserial throughout their whole length. According to the original description, the fourth right arm has large irregular proximal suckers, succeeded by four in a row of much smaller size; distally the suckers become very minute, but appear to be in four rows to the tip of the arm. The hectocotylus on the fourth left arm is rather obscure. It is situated on the distal half of the arm where the suckers on the dorsal border become more minute and are separated considerably from the ventral suckers which are reduced to a single row. This arrangement persists for about six rows. The distal portion has minute suckers placed four in a row.

The tentacles are slender with short clubs (pl. 43, fig. 257). The swimming-membrane extends beyond the base of the club on the tentacular stem. The protective membranes are narrow and separated at the base. The suckers are arranged in about five longitudinal series, but in fact they form very oblique transverse series of eight. In the middle of the club four or five suckers of the third longitudinal series are much wider than the other ones. The tentacular suckers have finely dentate chitinous rings; those of the arm-suckers are slightly notched or smooth.

According to the original description, the shell is of the *Doratosepion* type with a spine, but we do not have any further details.

REMARKS: The shell being practically unknown, we must wait for more material before being able to compare this species with other ones.

34. ***Sepia kobiensis*** Hoyle, 1885
(Pl. 19, figs. 116–120; pl. 43, fig. 255; pl. 44, fig. 264)

Sepia andreanoides Hoyle, 1885, p. 193; 1885*a*, p. 297; 1886, p. 139, pl. XXI, figs. 11–19, pl. XXII, fig. 11; Pilsbry, 1895, p. 3; Joubin, 1897, p. 102; ? Adam, 1939*c*, p. 38, pl. I, fig. 6.
Sepia (*Doratosepion*) *andreanoides*, Berry, 1912, p. 423; ? Massy, 1916, p. 229; Ishikawa, 1924, p. 194.
Sepia kobiensis Hoyle, 1885, p. 195; 1885*a*, p. 300; 1886, p. 142, pl. XVIII, figs. 7–14; ? 1905, p. 982; Appellöf, 1886, p. 20, pl. 3, fig. 7; Ortmann, 1888, pp. 654, 665; Wülker, 1910, p. 16; Sasaki, 1920, p. 194; Adam, 1939*c*, p. 39.
Sepia (*Doratosepion*) *kobiensis*, Berry, 1912, p. 423; Sasaki, 1914, p. 617; ? Massy, 1916, p. 230; Sasaki, 1929, p. 203.
Sepia kobiensis var. *typica* Sasaki, 1929, p. 204, fig. 111, pl. XIX, figs. 1–4.
Sepia kobiensis var. *andreanoides*, Sasaki, 1929, p. 206, figs. 112–114, pl. I; fig. 7, pl. XIX, figs. 5–7.
Sepia kobiensis var. *sagamiana* Sasaki, 1929, figs. 112–114.
Sepia kobiensis var. *toyamensis* Sasaki, 1929, p. 209, fig. 115, pl. XIX, figs. 8–12.
Sepia kobiensis var. *beppuana* Sasaki, 1929, p. 211, fig. 116, pl. XIX, figs. 13–15.
Sepia kobiensis var. *crassa* Sasaki, 1929, p. 213, pl. XIX, figs. 16–18.
Sepia kobiensis var. *albatrossi* Sasaki, 1920, p. 195, pl. XXVI, figs. 2 & 3; 1929, p. 214, fig. 117, pl. XIX, figs. 19–26.

TYPE LOCALITIES: Yokohama market (*S. andreanoides*); Bay of Kobe (*S. kobiensis*); Toyama Bay (*var. toyamensis*); Beppu Bungo Province (var. *beppuana*); Enoura, Suruga Province (var. *crassa*); Okinoshima, Krusenstern Strait (var. *albatrossi*).

GEOGRAPHICAL DISTRIBUTION: Japan; ? Laccadive Sea, 11°14′30″N., 74°57′15″E., 68–148 fms.; 13°36′N., 47°32′E., 130 fms.; ? S. of Ceylon, 6°2′30″N., 81°29′E., 52–68 fms.; ? Kolumadulu Atoll, 35 fms.; ? Persian Gulf, 26°20′N., 53°54′E., 53 fms.; ? off C. Negrais, Burma, 16°0′N., 93°37′E., 40 fms.; ? Poeloe Weh.

MATERIAL:

a. Yokohama market; B.M. 1889.4.24.78–79; 1 ♂, 1 ♀ (syntypes of *S. andreanoides* Hoyle).

b. Challenger Sta. 233; 34°39′N., 135°14′E., Bay of Kobe, Japan, 8 fms., 17.v.1875; B.M. 1889.4.24.81; 1 ♀ (holotype of *S. kobiensis*).

MEASUREMENTS:

ANIMALS OF *S. andreanoides* (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a	♂	60	85	43	21	33	—	—	42
	♀	60	83	45	24	35	—	—	43

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	♂	60	32	30	33	133	10	1·65	0·4
	♀	60	37	38	38	—	—	1·35	—

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Observations.
a	? ♀	60	22	9	66	*S. andreanoides* pl. 19, figs. 118–120
b	♀	40·5+	±17·5	±9·4	±62	*S. kobiensis*, pl. 19, 116 & 117

DESCRIPTION: *Sepia andreanoides*. In the collection of the British Museum we found only two of the three specimens mentioned by Hoyle but not the shell figured by the author (pl. XXI, figs. 14–16) which is longer, if the indication "natural size" is correct. As the two animals we examined show the same length, we are not sure if the shell we figure (pl. 19, figs. 118–120), and which had already been extracted, belongs to the male or the female. But as a fragment of a second shell is in the jar with the animals, the width of which is only 12 mm, we presume that the figured shell belongs to the female.

The quadriserial arm-suckers in both sexes are globular, the median ones being larger than the marginal ones.

The tentacular club is narrow; the swimming-membrane extends beyond the base of the sucker-bearing surface and the dorsal protective membrane is rather wide (pl. 44, fig. 264). The suckers are apparently arranged in four or five series, but form in fact oblique transverse rows of eight; the suckers of the third longitudinal series are larger than the other ones, contrary to the indication in the original figure (pl. XXI, fig. 13) which shows them as sub-equal.

The hectocotylus is very characteristic and differs slightly from the original figure (pl. XXII, fig. 11) which seems to show a median keel in the transformed distal part. In fact, this is a shallow groove and it is described correctly in the text (p. 139). But Hoyle did not mention the fact that the extreme distal part again bears four rows of normal, minute suckers, mostly hidden by the protective membranes. There are about 12 rows of normal suckers on the proximal half.

The shell is elongate, widest in the first third of its length, obtusely acuminate at the anterior end and regularly tapering towards the posterior end, with the exception of the outer cone which forms a shallow, cup-like widening (pl. 19, figs. 118–120).

The dorsal surface is calcified, with a faint median rib; the fine granulation is partly arranged in longitudinal lines and limited by two narrow, calcareous, marginal ridges. The ventral surface shows

a narrow, shallow, median groove in the striated area and a broader depression in the anterior part of the last loculus. The striae are convex with a faint incurvation in the middle.

The inner cone has a well-developed, elongated, posterior portion and very narrow lateral limbs that disappear anteriorly nearly half-way along the striated area. The latter is separated from the outer cone by two smooth, very narrow, marginal zones.

The outer cone is very narrow, except at its posterior end, where it forms a cup-like widening, surrounding the inner cone.

The strong spine is broken, but is distinctly directed towards the dorsal side.

Sepia kobiensis. This specimen agrees with the original description. The arms seem very much contracted and do not show the elongate tips which characterize *S. andreanoides*.

The tentacular club (pl. 43, fig. 255) is better preserved than in *S. andreanoides*. It has a broad swimming-membrane which extends beyond the base of the club. The dorsal protective membrane is broad, attaining about half the width of the sucker-bearing surface. The suckers are apparently in four or five series, but actually form oblique transverse rows of eight, five suckers from the third longitudinal series being much larger than the other ones. This difference in size is more pronounced than in *S. andreanoides*, but this may be partly due to better preservation.

The shell shows some small differences compared with that of *S. andreanoides*. It is narrower, the longitudinal striation of the dorsal calcareous covering is less distinct and the posterior portion of the inner cone shorter (pl. 19, figs. 116 & 117).

REMARKS: We agree with Sasaki (1929, p. 203) that *S. andreanoides* and *S. kobiensis* cannot be separated specifically, and although *S. andreanoides* has page-priority, we have to follow Sasaki (1929, p. 206) who described *S. andreanoides* as a variety of *S. kobiensis*.

This seems to be a common Japanese species, but we are not sure that the references from other regions are correct.

Massy (1916, pp. 229 and 230) reported both species from the same stations in the Laccadive Sea and S. of Ceylon and also *S. andreanoides* from 13°36′N., 47°32′E., as well as *S. kobiensis* from the Persian Gulf and from off C. Negrais, Burma. Most of the specimens she examined were very small, 20–21 mm in dorsal mantle-length, and only the male *S. andreanoides* from the Laccadive Sea reached 48 mm in dorsal mantle-length.

She states that the hectocotylus and the shell of this animal agree with the description of the type, but "about twelve of the club suckers are as large as those of the arms". As to *S. kobiensis* (p. 231), she states that "The outline of the striated area of the shell seems a little different in these specimens to the description of the type and to the illustration of Appelöf (1886, pl. 3, fig. 7*a*). The present examples have no median indentation in the curved line which more resembles that of the shell of *S. esculenta* Hoyle. The line is, however, somewhat irregular, especially in the earlier stages, and in all other respects there is no deviation from the description of the type".

We wonder if Massy's material did not belong to *S. trygonina* (see p. 84) or to some other Indian Ocean species with an elongate shell, but without having seen the specimens it is impossible to come to any decision.

We have the same doubt about the specimens of *S. kobiensis* reported by Hoyle (1905, p. 982) from the Kolumadulu Atoll.

As to the shell which Adam (1939*c*, p. 38, pl. I, fig. 6) reported from Poeloe Weh, as belonging to *S. andreanoides*, we are almost certain that it belongs in fact to another species, perhaps *S. murrayi*.

According to Sasaki (1929, p. 203) *S. kobiensis* is "one of the commonest *Sepia* in Japan and at the same time the hardest to identify owing to its marked variation". As the specimens which he examined (p. 204), show marked variations which were not linked by intermediate forms, he separated them into six varieties "until our further knowledge on the subject should necessitate a change". Un-

fortunately the key for the identification of these varieties does not always agree with the descriptions in the text. For example: var. *typica* and var. *toyamensis* are enumerated under "Breadth of shell in female below 22% of the length", but this breadth is 24% in the former and 21–23% in the latter (see our comparative table, p. 77).

As we did not have enough Japanese material at our disposal, we are unable to discuss the value of these varieties for which we refer to Sasaki's monograph.

In the comparative table on p. 77, we have reproduced the relative measurements of the shells of most of the other small species which more or less resemble *Sepia andreana* Steenstrup. We have not included the Australian forms which the Australian authors have included in a special genus or sub-genus *Arctosepia* Iredale, whose animals are undescribed up to the present and whose shells show a different ventral surface (see p. 80 under *Sepia braggi*). In this connexion neither do we discuss species like *S. arabica* (p. 96), *S. burnupi* (p. 81), *S. trygonina* (p. 84), and *S. elongata* (p. 86) whose shells, although very slender, are distinctly different from those mentioned in the table.

Nearly all these species are Japanese; some of them have been reported from the Indian Ocean, but as we pointed out (p. 73) these records are subject to doubt. There is only one exception: *S. kiensis* (p. 78) from the Arafura Sea, which is unsufficiently known.

Unfortunately, as noted, we had only a few Japanese species at our disposal and the following discussion is principally based on Sasaki's monograph (1929).

Although the shells of most of these species resemble each other very closely, the animals may show unmistakable differences, especially the males. If we compare the shells, we have to keep in mind that those of the females are generally broader than those of the males and that the young animals have a relatively broader shell than the older ones.

Some of these species are rather difficult to compare because only the females are known (*S. kiensis*) or only the males (*S. erostrata*, *S. misakiensis*, *S. peterseni* and *S. tokioensis*).

Sepia appellöfi (p. 60) and *S. tenuipes* Sasaki (1929, p. 193, pl. XVIII, figs, 1–9) differ from all the other species in their tentacular clubs which bear uniform, minute suckers, arranged in eight series.

In the male of the latter species, the dorsal arms are about twice as long as the others, which are sub-equal. The suckers of these dorsal arms are quadriserial on the proximal halves and biserial on the effilated distal halves. On the lateral arms they are biserial at the distal tips and on the ventral ones quadriserial throughout. The left ventral arm of the male is hectocotylized, showing seven or eight transverse rows of normal suckers on the proximal half, whereas the distal half has a longitudinal furrow and minute suckers.

The arms of the female are sub-equal according to Sasaki (1929, p. 193), being "about two and a half times the dorsal length of mantle"; this statement is certainly erroneous, because his table of measurements shows them to measure 40% of the mantle-length. The suckers are biserial on the distal third of the dorsal arms and on the filiform distal half of the lateral ones, whereas they are quadriserial throughout on the ventral arms.

The shell is rounded at the anterior end, tapering regularly towards the posterior end, which is terminated by a small, cup-shaped outer cone. The dorsal surface has a faint median rib; its median third is covered with calcareous rugosities, the coarser ones of which form longitudinal lines.

The ventral surface is convex in its greater part, with a narrow shallow median groove. The striae are convex with a small median incurvation. The inner cone is thin and narrow throughout, its posterior part scarcely prominent, enclosing a narrow depression.

According to the author (p. 194) these specimens agreed very well with Ortmann's description (1888, p. 653) of *S. andreanoides* Hoyle, so that previously he referred them to the latter species (Sasaki, 1914, p. 614). But *S. tenuipes* differs from *S. andreanoides* in the dorsal arms of the male, the lateral arms of the female, the uniform tentacular suckers and the shape of the shell. In fact, the

general form of the shell more resembles that of *S. erostrata* Sasaki, but the latter seems to have no spine, and the animal is different.

Sepia erostrata Sasaki, 1929 (p. 183, pl. XVII, figs. 7–9), is based on a small male specimen. Its dorsal and ventral arms are much longer than the lateral ones. The arm-suckers are quadriserial on the proximal part, biserial on the distal part of the lateral arms, and absent, perhaps lost, on the distal part of the dorsal and ventral arms. The suckers of the middle part of the left ventral arm are smaller than the corresponding ones of the right arm. The tentacular suckers are irregularly arranged and according to Sasaki's fig. 8, those of the third series are much larger than the other ones.

The shell is lanceolate, broadest a little in front of the middle and rounded at the anterior end. The dorsal surface is slightly convex, with a faint median rib. The ventral surface is strongly convex in the anterior part and a little concave near the posterior end. The striated area has a faint, linear, median groove and has regularly rounded striae, the last one being nearly semi-circular. The inner cone is thin and narrow throughout and the outer cone is narrow, terminating in a small cusp-like expansion "which has no marked rostrum behind but a low rounded eminence".

Sepia andreana Steenstrup, 1875 (p. 474, pl. XI, figs. 11–19) has been re-described by Sasaki (1929, p. 196, pl. I, fig. 6, pl. XVIII, figs. 12 & 13) who examined about 300 specimens, measuring up to about 120 mm in mantle-length. The dorso-lateral arms of the male are about three times as long as the others, and attain about the same length as the mantle. Their suckers are quadriserial on the proximal third, then become biserial and are finally rudimentary on the distal parts. On the lateral arms of the female, the suckers are quadriserial on the proximal two-fifths and biserial on the remaining parts.

On the dorsal arms of both sexes and the ventro-lateral ones of the male, the suckers are quadriserial except at the tips where they are biserial. On the ventral arms they are quadriserial throughout. The left ventral arm of the male is hectocotylized, its proximal half bearing 10 rows of normal suckers and its distal half only rudimentary suckers.

The tentacular suckers, of unequal size, are arranged in oblique transverse rows of eight, four in the middle attaining thrice the diameter of the marginal ones.

The shell is lanceolate, bluntly rounded at the anterior end and acuminated at the posterior end, which has a small, discoidal outer cone. The dorsal surface is convex with a faint median ridge; it is granulous and the coarser granules form longitudinal lines. The ventral surface is convex with a faint median groove along the whole length. The striae are semi-circular or triangular in the anterior part of the striated area.

According to Okada (1927, p. 177) *S. andreana* is a cold water element of the Japanese marine fauna, whereas *S. peterseni* Appellöf (1886, p. 23, pl. II, figs. 1–6, pl. III, fig. 21) is an inhabitant of temperate water.

Sepia peterseni has also been re-described by Sasaki (1929, p. 195, pl. XVIII, figs. 10 & 11, pl. XIX, fig. 27, text-fig. 109) who examined 46 male specimens, measuring up to 118 mm in mantle-length, which is about the same size as in *S. andreana*.

Its dorso-lateral arms are very long, attaining a length 4–6 times that of the mantle, but the other arms measure less than half the mantle-length. On the dorso-lateral arms the suckers are quadriserial up to the ninth or tenth rows, then they become biserial and finally form single series. On the distal halves of these arms the protective membranes are fused and no suckers can be seen externally. On the dorsal and ventro-lateral arms the suckers are obliquely quadriserial in the proximal parts, biserial in the distal, whereas they are quadriserial throughout on the ventral arms. The left ventral arm bears about 10 rows of normal suckers on the proximal part, those on the distal third being rudimentary. The tentacular club shows the suckers apparently in five or six series, but actually they form oblique transverse rows of eight; they are unequal in size, five or six in the middle being largest.

The shell is lanceolate, slender and thick, acuminated at both ends and is terminated at the posterior end by a small, cup-shaped, outer cone. The dorsal surface has a faint median rib, the median third is covered by fine calcareous granules, the coarser ones forming longitudinal lines. The ventral surface is strongly convex with a narrow, shallow, median furrow along the whole length. The striae are convex and are semi-circular at the anterior end of the striated area. The rim of the V-shaped inner cone is very narrow but at the posterior end forms a flat ledge enclosing a very narrow but relatively deep depression.

The peculiar long dorso-lateral arms are only seen in adult specimens, the young ones recall *S. andreanoides*.

Sepia tokioensis Ortmann, 1888 (p. 653, pl. XXIII, fig. 3), which has been re-described by Sasaki (1929, p. 200, fig. 110), who examined 26 males, measuring up to 88 mm in dorsal mantle-length, has a rather broad, oval body. At their posterior end, the fins are thickened and expanded into lobes, marked off from the remaining parts by notches. The arms are sub-equal, the dorsal ones being slightly longer. The arm-suckers are quadriserial.

The distal suckers of the left ventral arm are slightly smaller than those of the right arm, otherwise no hectocotylization is visible. The tentacular suckers are arranged in oblique transverse rows of eight, unequal in size, four or five in the middle of the club being much larger than the others.

The shell is elongate-rhomboidal in outline; it is relatively thick and terminates in a small, discoidal outer cone. The dorsal surface is convex, slightly elevated in the median line and is covered with calcareous rugosities, the coarser ones forming longitudinal lines in the lateral parts. The ventral surface is convex in the anterior parts, with a distinct, narrow, median groove. In the anterior part of the striated area the striae are semi-circular. The rim of the inner cone is very narrow; its posterior end is a little prominent, forming a flattened cone, about as long as the spine, and enclosing a narrow but relatively deep space.

The original description of this species (Ortmann, 1888, p. 653) differs from Sasaki's description in several points: the extremities of the arms being slender, the ventral arms being as long as the dorsal ones, the distal suckers are biserial, and the locular index is greater, being 36–40 instead of 26–38. In our opinion these differences are not very important, especially those concerning the arms which may be attributed to the state of preservation.

Sasaki (1929, p. 202) doubts the correctness of Berry's record of this species (1912, p. 423) from Aomori, because in this region only *S. andreana* has been found by him, the female of the latter species closely resembling *S. tokioensis*. But the table of measurements (p. 78) shows that *S. tokioensis* has a much thicker shell than *S. andreana*.

Sepia misakiensis Wülker, 1910 (p. 15, figs. 5 & 6, 19–22) was described as being closely related to *S. tokioensis* and to be perhaps only a variety of the latter. Sasaki (1929, p. 202) is of the same opinion, but his descriptions show slight differences. The body of *S. misakiensis* is more slender but the fins show the same posterior lobes. The hectocotylization was indistinct in the three male specimens examined by Sasaki, but Wülker states: "sie scheint in einer Verminderung der Saugnäpfe am Grunde des vierten linken Armes zu bestehen." Sasaki (1929, p. 203) describes the anterior striae of the striated area as "arcuate, with a deep indentation in the middle", which corresponds to the original figure (Fig. 19). This differs from the outline in *S. tokioensis* where they are semi-circular with only a slight incurvation in the middle.

Sepia carinata Sasaki, 1920 (p. 192, pl. XXV, fig. 2, pl. XXVI, fig. 1; 1929, p. 181, fig. 105, pl. XVII, figs. 4–6), which was based on two very young specimens from the Sagami Sea, probably does not belong in this group of species. The dorsal mantle-margin projects forward strongly and the fins are rather short. The arm-suckers are quadriserial except at the extreme bases and tips of the arms, where they are biserial. On the tentacular club the unequal suckers are arranged in oblique transverse series of eight. The shell is broad anterior to the middle and is acuminate towards both

ends. The dorsal surface is convex, flattened near the anterior end and with a faint median rib. The ventral surface has a narrow, shallow, median groove. The striated area is convex in its anterior part and separated from the outer cone by two smooth marginal zones. The striae are regularly convex. The limbs of the inner cone are narrow and the posterior portion is thickened. The outer cone is narrow in its lateral parts, forming a cup-shaped expansion at the posterior end. The spine is well developed; the author does not state if it has any keels.

COMPARATIVE TABLE OF RELATIVE MEASUREMENTS OF SHELLS OF THE *Sepia andreana*-LIKE SPECIES

Species	Distribution	Sex	L. in mm	W.	Th.	Sp.	Author
S. andreana Steenstrup	Japan	♂	110	15·5	6·4	—	Sasaki, 1929, p. 199
		♂	95	17	6·3	—	,,
		♂	70	19·5	7·8	—	,,
		♂	55	23·5	8·2	—	,,
		♂	43	26·5	8·8	—	,,
		♀	105	21	5·7	—	,,
		♀	65	23	6·9	—	,,
S. andreanoides Hoyle	Japan	♂	60	21	—	—	Hoyle, 1886, p. 140
		♀	59	22	—	—	,,
		♂	58	17·5	—	7·8	Sasaki, 1929, p. 208
		♂	53·5	19	—	7·4	(*S. kobiensis* var. *andreanoides*)
		♂	50	19	—	8·0	,,
		♀	69	18·5	—	7·2	,,
		♀	66·5	19·5	—	6·9	,,
		♀	62	19·5	—	7·4	,,
S. appellöfi Wülker	Japan	? ♀	77	28	—	—	Wülker, 1910, p. 15
		♀	89	? 27[1]	9	—	Sasaki, 1929, p. 186
		♀	74	27	9·5	—	,,
		♀	57	28	12·3	—	,,
		♀	55	25·5	10·6	—	,,
		♀	47	32	10·6	—	,,
S. erostrata Sasaki	Japan	♂	45	20	9	—	Sasaki, 1929, p. 184
S. kiensis Hoyle	Arafura Sea	♀	37	30[2]	—	—	Hoyle, 1886, p. 142
S. kobiensis Hoyle	Japan	♀	42	16·5	—	—	Hoyle, 1886, p. 144
var. *typica* Sasaki	Japan	♂	31·5	22	11·1	3·8	Sasaki, 1929, p. 206
		♀	23	24	12·6	4·3	,,
var. *toyamensis* Sasaki	Japan	♂	64	17	7·8	4·7	Sasaki, 1929, p. 211
		♂	62	20	9·7	4·8	,,
		♂	55	22	8·2	5·4	,,
		♀	70	23	7·1	4·7	,,
		♀	67	21	7·5	4·5	,,
var. *beppuana* Sasaki	Japan	♂	57	17·5	7·0	—	Sasaki, 1929, p. 212
		♂	52	17·5	7·7	—	,,
		♂	50	18	8·0	—	,,
		♀	70	20	7·1	—	,,
		♀	58	22·5	8·6	—	,,
		♀	53	22·5	9·4	—	,,

Table continued overleaf

[1] Sasaki mentions the width as being 14 mm; probably this is a printing error for 24 mm, otherwise the relative width would be 15·7%.

[2] Hoyle's figures show a width of only 24–25%.

Species	Distribution	Sex	L. in mm.	W.	Th.	Sp.	Author
var. *albatrossi* Sasaki	Japan	♂	34	20·5	11·8	4·4	Sasaki, 1929, p. 216
		♀	28	25	8·6	4·3	,,
		♀	26·5	26·5	9·4	—	,,
S. misakiensis Wülker	Japan	?	66	22	12	4·5	Wülker, 1910, pl. III fig. 19
		♂	67	25·5	12	4·5	Sasaki, 1929, p. 203
		♂	59	23·5	10·2	3·4	,,
S. peterseni Appellöf	Japan	♂	110	14·5	—	—	Appellöf, 1886, p. 23
		♂	118	16	5·9	4·2	Sasaki, 1929, p. 197
		♂	105	16	6·2	4·8	,,
		♂	92	17·5	7·6	4·4	,,
		♂	77	19·5	7·8	4·5	,,
		♂	59	20·5	8·5	5·9	,,
		♂	58	20·5	8·6	4·3	,,
S. tenuipes Sasaki	Japan	♂	105	18	7·1	4·8	Sasaki, 1929, p. 194
		♀	81	23·5	9·3	4·9	,,
S. tokioensis Ortman	Japan	♂	66	19	—	—	Ortmann, 1888, pl. XXIII, fig. 3
		♂	88	20·5	9·1	4·5	Sasaki, 1929, p. 201
		♂	82	22	8·5	4·9	,,
		♂	78	23	9·0	3·8	,,
		♂	74	23	10·8	4·0	,,
		♂	45	26·5	11·1	4·4	,,

35. ***Sepia kiensis*** Hoyle, 1885

Sepia kiensis Hoyle, 1885, p. 194; 1885*a*, p. 299; 1886, p. 141, pl. XVII, figs. 6–11; Adam, 1939*c*, p. 39.

TYPE LOCALITY: off the Ki Islands, Arafura Sea, 5°49′15″S., 132°14′15″E., 140 fms., blue m.
MATERIAL:

a. Holotype: Challenger Sta. 192, 26.ix.1874; B.M. 1889.4.24.80; 1 ♀.

DESCRIPTION: The only specimen is completely hardened in alcohol and the shell damaged.

According to the original description the arm-suckers are quadriserial throughout. The hectocotylus is unknown. The tentacular club has narrow protective membranes and a swimming-membrane which extends beyond the base of the club; "the suckers are in four or five series, which are slightly larger towards the inner margin".

The anterior portion of the shell is lacking. The remaining part somewhat resembles the shell of *Sepia kobiensis*, but it is relatively broader and flatter. The dorsal surface shows a much broader calcareous area limited by two narrow, marginal ridges, as in *S. kobiensis*. The spine is the same. The inner cone is very similar, but its posterior portion is shorter and the limbs wider apart, because of the broader striated area, which has a median groove. The smooth zones between the striated area and the outer cone are much narrower. The original measurements of the shell were: 37 × 11 mm (W. = 30%) but the figures show a much narrower shell, with a width of 24–25%.

REMARKS: Without examining more material in perfect condition, especially of the male, it is impossible to decide how far this species is related to *Sepia kobiensis*.

Judging from the original figures of the shell, the general form recalls that of *Arctosepia rhoda* Iredale (1954, p. 75, pl. IV, figs. 10–12) from Point Cloates, mid-western Australia. The latter species was based on a single shell, measuring 52 × 12 × 6 mm (W. = 23%; Th. = 11·5%). The

figures are very poor, not showing any details of the striated area; a dark line in the middle of figure 12 may be interpreted as a median groove, but according to the text it has "a comparatively short, broad posterior area, well elevated and showing, instead of a linear groove, a raised rib along the striated area, but the linear groove appears in the last loculus. Practically the whole ventral area, save the extremities, is elevated".

36. *Sepia braggi* Verco, 1907
(Pl. 19, figs. 121–126)

Sepia braggi Verco, 1907, p. 213, pl. XXVII, fig. 6; Hedley, 1908, p. 134; 1918, p. M33; Gatliff & Gabriel, 1909, p. 37; May, 1910, p. 307; Chapman, 1912, p. 23, pl. I; Jackson, 1931, p. 149.
Arctosepia braggi, Verco & Cotton, 1928, p. 127; Cotton, 1929, p. 90; 1931, p. 41, fig. 9; Macpherson & Chapple, 1951, p. 156; Iredale, 1954, p. 74; Iredale & McMichael, 1962, p. 99; Hope Macpherson & Gabriel, 1962, p. 409.
Sepia (*Arctosepia*) *braggi*, Cotton & Godfrey, 1940, p. 440, fig. 428.
Sepia elongata Tate & May, 1901, p. 351 (*non* d'Orbigny, 1845).
Sepia sp. Meyer, 1909, p. 335, fig. 11.

TYPE LOCALITY: Glenelg, S. Australia.
GEOGRAPHICAL DISTRIBUTION: Australia; Tasmania.
MATERIAL:

a. Torquay, Victoria (Australia); B.M. 1926.2.3.27–28; 2 shells.
b. Adelaide, S. Australia; B.M. 1952.11.24.34–36; 3 shells.
c. Semaphore, S. Australia; B.M. 1962257W; 4 shells (det. Cotton).

MEASUREMENTS:

SHELLS (IN % OF SHELL-LENGTH)

Loc.	L. in mm	W.	Th.	Str.z.	Spine	Observations
a	61·4	20	8·1	67	2·4	
	56·3	21	8·3	62	2·5	
b	56·0	20	8·0	66	3·6	pl. 19, figs. 121 & 122
	38·4	19·5	8·3	76	3·9	pl. 19. figs. 124–126
	29·0	21·5	9·0	54	3·4	
c	35·5	18·0	7·3	67	4·2	
	32·5	21·5	9·2	63	—	

DESCRIPTION: The shell is very elongate, it is broadest in the anterior third, acutely rounded at the anterior end and acuminate posteriorly. The dorsal surface has a distinct, but low, median rib, vanishing towards the posterior end; it is weakly granulous, with longitudinal lines in its anterior part and rose-coloured in its posterior part which is neatly curved towards the ventral side and terminating in a rather short spine. The latter has a constriction at its base; it is swollen on the dorsal side, turned upwards, sometimes slightly curved, and its ventral side is concave. The ventral surface of the shell shows a narrow median groove along its whole length. In the anterior part of the striated area the surface is flattened in the middle, with abruptly sloping, flat, or even concave lateral parts; the striae are regularly convex posteriorly and slightly more angular near the last loculus. The striated area is separated from the outer cone by smoother, narrow, marginal zones, separated from the striated area by the lateral limbs of the inner cone, which are long, narrow ridges, the posterior part forming a slightly sharper ledge which surrounds the posterior excavation. The narrow outer cone forms two posterior wings which surround the posterior part of the inner cone; from the latter radiate a few tiny calcareous keels over the chitinous expansion of the outer cone.

Remarks: The shell of *Sepia braggi* differs from that of *S. kobiensis* in the less developed median rib, the weaker granulation and in the shorter posterior portion of the inner cone.

The shell of *Sepia elongata* differs in its much more elevated ventral surface, especially in the anterior third, in the more developed, differently-shaped, posterior part of the outer cone and the much longer spine which is not constricted at the base.

Up to 1926, *Sepia braggi* was the only Australian representative of these narrow shells. According to Iredale (1926, p. 193) "The only generic name in existence is *Doratosepion* Rochebrune proposed for the Japanese species *S. andreana* Steenstrup".

He forgets to mention that Rochebrune (1884, p. 97) also included in this genus two species from the Red Sea: *D. elongatum* and *D. trygoninum*. In the diagnosis of *Doratosepion* the shell is described (p. 95) as being: "excessivement allongé, étroit, à l'extrémité postérieure présentant deux ailes généralement coupées à angle droit formant une sorte de capuchon variable d'aspect et surmonté d'un rostre plus ou moins long très aigu et conique." In Iredale's opinion there appears to exist more than one generic form "and it is suggested that at least a subfamily is necessary to include these Cephalopods. In order to enable correct study of the Australian animals to be undertaken, I therefore propose the new generic name *Arctosepia* and name *A. limata* as type". The original diagnosis of this genus, the animal of which is still unknown, describes the shells as "very small, very narrow, ventrally swollen, posteriorly sweeping forward and narrowing, a chitinous outer cone appearing as a hood, the spine rounded and more or less curved, inner cone missing, fusing with the edges of the striated area". According to this diagnosis nothing permits us to separate *Arctosepia* from *Doratosepion*. The statement "inner cone missing" is very confusing: if it is missing how can it fuse with the edges of the striated area? Moreover Iredale's figures (pl. XXIII, figs. 6 and 8) show an inner cone.

The type-species of *Arctosepia*, *A. limata* Iredale (1926, p. 193, pl. XXIII, figs. 7 & 8) from Manly Beach, New South Wales, is said to differ from *S. braggi* in being smaller "proportionately broader, less narrowed posteriorly, different shape, etc." The slightly broader shell, which may be a sexual character, does not seem to justify the specific separation. The same seems to be true for Iredale's second new species, *A. versuta* (p. 194, pl. XXIII, figs. 5 and 6).

In 1954, Iredale (p. 74) discussed the species of *Arctosepia* again. Under *A. braggi*, he states:—

> "It was suggested that in this section two series could be distinguished, and the name *Arctosepia* was introduced for the small forms found on the New South Wales coast. A larger bone has been named *Sepia braggi* from South Australia, and this larger form is not able to be confused with the typical *Arctosepia*. It has been given a range of Victoria, Tasmania, South Australia and Western Australia, and now I add it to the New South Wales faunula, as Whitley has collected a specimen at Narooma, on the South coast. The complex *braggi*, as admitted above, may be capable of subdivision, when studied geographically."

Iredale (1954, p. 74, pl. V, figs. 19–21) has created a new sub-species: *A. braggi xera* for shells from N.W. Tasmania.

Compared with *S. braggi* it is described as being larger:—

> "more elongate, with a wider posterior area, which shows a median linear groove its whole length, even on the last loculus. The dorsal rib is very faint posteriorly, but well indicated anteriorly, while the horny margin is easily seen throughout its length. The posterior horny hood is small."

The type measures 78 × 16 mm (20·5%), other specimens: 51 × 12 mm (23·5%), 57 × 14 mm (24·5%); 68 × 15 mm (22%), 73 × 16 mm (22%), 74 × 15 mm (20·5%) and 80 × 17 mm (21·5%). Under *A. limata*, Iredale (1954, p. 74) states that hundreds of these small bones have been collected but none exceeding the measurements of the type, 36 × 8 mm (22%), in the Sydney district. Other

specimens have been found on the north coast of New South Wales and South Queensland.

> "These small bones may occur further north, as they are easily overlooked, and the northern bones might belong to different species."

Macpherson & Chapple (1951, p. 156) mention it from Victoria.

Under *Arctosepia versuta*, Iredale (1954, p. 75) states:—

> "In Southern Australia, large shells (for the group) occur with the name *braggi*, and it would appear that these small New South Wales shells are degenerate representatives of the larger one. Thus, Whitley collected a series of *braggi*-like bones in North-western Tasmania, and while most of these are obviously of the true *braggi* style, some others are of the *versuta* form, and appear to be far larger relatives."

In our opinion all this is very confusing; we have never seen any "degenerate" Cephalopods. Iredale (1954, p. 75) states that compared with *A. limata*, the shell of *A. versuta* is:—

> "smaller, the growth lines more closely packed, the posterior end much less rapidly tapering, the anterior ventral more swollen, less excavate posteriorly, and with more numerous striae";

we do not know which of these characters the author considers as an indication of degeneration. For the specimens from Tasmania mentioned above he creates a new species *Arctosepia treba*. These shells measure: 51 × 10 mm (19·5%) and 48 × 10 mm (21%); they are:—

> "elongate and narrow, the width never increasing rapidly, the ventral surface elevated, the median furrow in one specimen elevated into a rib, in the other normal, the striae rather coarse, the hood small, the spine short and thickened, the dorsal area smoothish, the median rib scarcely indicated."

The author adds that this species may have been confused elsewhere with *braggi*, passing as the male or immature. Finally, Iredale (1954, p. 75 pl. IV, figs. 10–12) describes a new species: *Arctosepia rhoda*, based on a shell collected at Point Cloates, Mid-western Australia. It measures 52 × 12 × 6 mm (W. = 23%; Th. = 11·5%) and judging from the figures it certainly differs from the above-mentioned species, being much more oval, like our *Sepia sewelli* (p. 62) and like *S. kiensis* (p. 78). According to the original description it has:—

> "a comparatively short, broad posterior area, well elevated and showing, instead of a linear groove, a raised rib along the striated area, but the linear groove appears in the last loculus. Practically the whole ventral area, save the extremities, is elevated. The dorsal area is comparatively smooth, with a narrow median elevated rib, and with a large amount of horny margin on the sides exposed. The spine is of the usual rounded style, while the hood is small."

Unfortunately the author does not describe the inner cone, which judging from his fig. 12 resembles that of *Sepia kobiensis*.

As long as the animals of all these species are unknown it is useless to discuss their status and their relationships. It is most unfortunate that Garrard (1961, p. 36) who mentions 13 live specimens of *Arctosepia versuta*, collected off the coast of New South Wales in 76–80 fms., and 96 fms. depth, did not describe the animals.

37. ***Sepia burnupi*** Hoyle, 1904
(Pl. 20, figs. 127 & 128)

Sepia burnupi Hoyle, 1904 (pars), p. 27, pl. I, figs. 188 & 189; Smith, 1916, p. 23, pl. II, fig. 5; ? Turton, 1932, p. 1.
Sepia (*Doratosepion*) *incerta* Massy, 1925, p. 219, pl. XIII, figs. 22, 23, 29–36; pl. XIV, figs. 40 & 43 (*non* Smith, 1916).
? *Sepia exsignata* Barnard, 1962, p. 250, fig. 3.

TYPE LOCALITIES: Umkomaas, Natal (*S. burnupi*); off Umhlanga River, Natal, 22–26 fms. (*S. exsignata*).

GEOGRAPHICAL DISTRIBUTION: South Africa.

MATERIAL:

a. Umkomaas, Natal (Burnup); B.M. 1905.1.19.5; 1 shell (holotype).

b. Umkomaas, Natal (Ponsonby); B.M. 1904.2.13.5; 1 shell (paratype).

MEASUREMENTS:

		SHELLS (IN % OF SHELL-LENGTH)				
Loc.	L. in mm	W.	Th.	Str.z.	Spine	Observations
a	49	20	6·1	±67	3·5	Holotype
b	45	19	6·7	—	3·3+	Paratype, pl. 20, figs. 127 & 128

DESCRIPTION: The shell is elongate, broadest in its anterior third and the posterior end is regularly curved towards the ventral side. The dorsal surface has a distinct median rib, limited by two narrow grooves, and has rather broad chitinous margins, the rest of the surface being finely granulous, but coarser in the posterior part where the granules form longitudinal lines. The ventral surface is not very thick, with a distinct median groove along its whole length. Two broad ribs separate the median part of the striated area from the two concave marginal zones which are less distinctly striated. The striae are convex in the anterior part and more and more angular towards the anterior end of the striated area. The limbs of the inner cone are narrow, slightly raised, forming a rounded ridge in the posterior part which surrounds a faint excavation. In the posterior part the limbs separate the central part of the striated area from the marginal zones; anteriorly they descend on these zones. The outer cone is narrow, forming two wings at the posterior end which together form a shallow calcareous expansion, surrounding the inner cone. The spine is gently curved upwards, without any keels.

The female animal has been described by Massy (1925, p. 219) as "*Sepia* (*Doratosepion*) *incerta*". It has short, sub-equal arms, with the suckers arranged four in a row, the median ones being largest; "frequently a 2- or 3-rowed series persists for a portion of an arm". The arms are much attenuated at the tips.

The tentacular club has five very large suckers of which the median three are the largest. The colour of the preserved animal is dull purplish-pink, the surface is smooth.

The relative measurements of these two females are:—

M.L.d. in mm	M.W.	H.W.	A.L. I	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.
90	49	33	54	58	64	60	142	16·5
80	54	30	45	61	56	62	—	—

The shell of the largest animal has a width of 24·5%.

REMARKS: In his original description of *S. burnupi*, Hoyle (1904, p. 27) confused three different species which were separated afterwards by Smith (1916, pp. 23–24) as *S. burnupi*, *S. incerta* and *S. confusa*. The latter author submitted his conclusion to Hoyle, who agreed that there were three forms, but who stated that *S. incerta* was the female form of *S. burnupi*. At that moment only the shells of these species were known.

The animal of *S. confusa* was described by Massy & Robson (1923, p. 435) and by Robson (1924*a*,

p. 647). Unfortunately in her descriptions of the two other species, Massy (1925, p. 215 and p. 219) described the animal of *S. burnupi* as *S. incerta*, and that of *S. incerta* as *S. burnupi*.

Probably this mistake was due to Hoyle's statement, because Massy (1925, p. 217) mentions: "it is significant that the present collection has produced 2 males of *S. burnupi* and 2 females of *S. incerta* E. A. Smith, which is a short-armed species." There is not the slightest doubt that the shell figured by Massy (1925, pl. XIII, fig. 34) as being *S. incerta* belongs in fact to *S. burnupi*. Our interpretation of these three species is substantiated by our descriptions and figures of the original and other material (p. 82).

The shell of *S. burnupi* is very closely related to that of *S. trygonina* (Rochebrune, 1884, p. 97, pl. V, fig. 1). Until now the male of *S. burnupi* has never been described, but we are almost certain that the males recently described by Barnard (1962, p. 250, fig. 3) as belonging to a new species, *S. exsignata*, are in fact *S. burnupi*. Barnard (p. 251) gives the following description of the shell of his new species:—

> "Shell resembling that of *burnupi* Hoyle (as restricted by Smith, 1916, p. 23, pl. 2, fig. 5). A low medio-dorsal ridge defined by shallow grooves, growthlines V-shaped. Striated area extending about $\frac{3}{4}$ the length, with deep median groove, striae more strongly V-shaped anteriorly than posteriorly, last loculus with minute obliquely-longitudinal striae; limbs of inner cone prominent, nearly parallel but diverging slightly; external to the limbs the chitinous margin is marked with curved striae (cf. Smith, 1916, p. 23, for *burnupi*)."

As Barnard (1962, p. 252) followed Massy's erroneous interpretation of *S. burnupi*, he thought that "no excuse is needed for introducing another specific name". The animals he studied were very small, the female 36 mm in dorsal mantle-length, the male 44 mm.

Unfortunately he does not give other measurements. The fins are separate posteriorly, rounded in the female and ending in small points (2–3 mm) in the male. The dorsal mantle-margin is not strongly produced, "as in Massy's figure of *incerta* (1925, pl. 13, not her figure of *burnupi*, pl. 12)".

In the female the dorsal and lateral arms are sub-equal, the ventral ones about $1\frac{1}{4}$ times longer, in the male the dorsal arms are "about $1\frac{1}{3}$ longer than lateral arms, and ventral arms about $1\frac{1}{4}$ longer than the dorsal arms". The suckers are quadriserial.

The dorsal arms of the male show a very peculiar transformation:—

> "proximally with 6 or 7 rows of normal-sized suckers, but thereafter decreasing in size, becoming minute and eventually obsolete; the inner protective membrane has about 10–12 small points, the outer membrane has about 16–18 cirriform processes, the middle and distal ones of which originate in the mid-line of the arm and alternate with the bases of the points on the inner membrane."

The ventral arms are also transformed. In one of the males the right ventral arm:—

> "has about 10 rows of normal suckers, thereafter the suckers begin to decrease in size, reduced to 3 in a row, and eventually to 2 rows of minute suckers, tip with 5 cirri. The left arm in this ♂ is similar but shows signs of hectocotylization: 4 thickened membranes on ventral margin, and tip with 8 cirri. The other ♂, although of the same size, is more developed: the right ventral arm has 7 cirri; the left ventral arm has 8 or 9 thickened ridges forming an expansion on the ventral margin, and 8 cirri on the tip."

The tentacular club has four enlarged suckers, the arrangement of the other ones is not described.

We do not understand Barnard's statement (p. 252):—

> "As regards the so-called 'species' *burnupi*, *incerta* and *confusa*, it must be admitted that up to the present we are dealing with *specimens* only, not species with well-defined and constant characters."

In fact, these three species are very well defined and easily distinguishable.

38. *Sepia trygonina* (Rochebrune, 1884)
(Pl. 20, figs. 129–131; pl. 37, figs. 220–221; pl. 46, fig. 277)

Doratosepion trygoninum Rochebrune, 1884, p. 97, pl. V, fig. 1; Adam, 1944, p. 228.

TYPE LOCALITY: Red Sea.

MATERIAL:

a. John Murray Exped. Sta. 10, 13°31′N., 42°31°E., Red Sea, 55 m, 17.ix.1933:1 ♂. B.M. 196386W.

b. John Murray Exped. Sta. 13, 12°12′30″N., 43°45′30″E., Gulf of Aden, 413 m, 19.ix.1933: 1 ♂ (L_M = 17·2 mm)[1]. B.M. 196387W.

c. John Murray Exped. Sta. 27, 11°57′12″N., 50°35′00″E. to 11°56′42″N., 50°39′12″E., Gulf of Aden, 37 m, 12.x.1933: 2 ♂, 5 ♀. B.M. 196388–94W.

d. Ennûr, 1929 (Coll. Winckworth); 2 shells (identified by Winckworth as *S. kobiensis* Hoyle = *S. andreanoides* Hoyle). B.M. 1952.11.24.32-33.

MEASUREMENTS:

ANIMALS (IN % OF DORSAL-MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
c	♂	43	86	43	21	32	79	9·5	—
a	♂	40	90	39	17·5	37	85	9	15
c	♂	37	89	46	22	36	81	8	19
c	♀	50	82	40	22	34	80	8	28
c	♀	50	78	45	28	30	76	5	28
c	♀	33	91	41	24	38	—	—	30

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
c	♂	43	32	26	30	—	—	0·95	—
a	♂	40	25	25	27	75	10	1·0	1·2
c	♂	37	27	27	27	122	9·5	0·8	1·1
c	♀	50	32	32	32	130	9	1·0	1·0
c	♀	50	32	34	32	150	9	1·0	1·2
c	♀	33	30	30	30	136	12	0·9	1·2

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
a	♂	40	21	8·5	65	3·5	
c	♂	43	23	7·0	65	$3·5^+$	
c	♂	37	23	9·2	65	$2·7^+$	
c	♀	50	22	8	68	4·0	
c	♀	50	21	7·6	72	4·0	pl. 20, figs. 129–131
c	♀	38	25	9·2	63	$3·9^+$	
d	—	47	22	6·4	73	—	

DESCRIPTION: The body is elongate oval but acuminate behind; the dorsal mantle-margin is acutely angular, reaching the mid-level of the eyes and the ventral margin is slightly emarginate.

[1] The station list gives a depth of 413 m for this station, but the tube is labelled 16 fms. and the date is given as 17.ix.33.

The fins begin a few millimetres behind the mantle-margin and do not reach the posterior end of the body (pl. 37, figs. 220 & 221).

The arms are sub-equal in length, the web is rather low, but is highest between the dorsal arms and between the dorso-lateral and ventro-lateral ones. All the arms are laterally compressed, the dorsal ones of the female specimens are rounded or have slight keels on the outer side of the distal halves, the dorso-lateral ones have keels along the whole of the ventral margins, the ventro-lateral ones have distinct but low swimming-membranes and the ventral ones have broad outer swimming-membranes. In the males the dorsal arms are much shorter than the other ones and are keeled over their whole length.

The suckers are quadriserial on all the arms of the males and on the dorsal and ventral arms of the females; on the lateral arms of the latter the suckers are quadriserial on the proximal two-thirds, but on the distal third they are arranged in two, widely-spaced, longitudinal series on each arm.

The ventral portion of the buccal membrane is not expanded in the female.

The tentacular club is rather short, with a well developed swimming-membrane on the dorsal side, extending beyond the base of the club (pl. 46, fig. 277). The dorsal protective membrane is broad and is separated from the ventral membrane at the base of the club. The suckers seem to be arranged in five longitudinal series, but in fact they are arranged in very oblique transverse rows of eight. The third longitudinal series bears about five very large suckers.

All the tentacular suckers have their chitinous rings finely dentate all around; the arm-suckers are dentate only on the distal halves of their rings.

The left ventral arm of the male is hectocotylized. In the largest male the proximal half of this arm is normal with about six rows or groups of four suckers; these are followed by a transformed portion of about 2 mm which is nearly completely devoid of suckers, its surface is hollowed out and covered by the large, wrinkled, protective membranes; the distal part of the arm has the normal arrangement. In the smallest male, the hectocotylus possesses, at its base, one pair of suckers, a group of three suckers and three transverse rows of four, occupying the basal third of the arm. On the middle third nearly all the suckers have disappeared, the protective membranes are larger, especially the ventral one which is thick and curved outwards; the whole transformed portion is transversely grooved. The distal third of this arm gradually narrows considerably and its surface is grooved, with a few minute suckers along its margins. This hectocotylus differs only slightly from the one described by Adam (1959, p. 147, fig. 8A) for *S. elongata*.

The third male has two groups of three and four groups of four normal suckers at the base of the hectocotylus, the distal half is nearly completely devoid of suckers, its surface is concave with transverse grooves and ridges, especially in the ventral part where the protective membrane is thick and curved outwards; the distal portion has only a few minute suckers on the dorsal side.

The specimens from the John Murray Expedition have elongate shells, these are broadest in the anterior third, the posterior ends are regularly curved towards the ventral side (pl. 20, figs. 129–131). The dorsal surface shows a faint indication of a low median rib and rather wide chitinous margins, the rest of the surface being finely granulous, forming a few longitudinal lines near the outer part of the granulous surface in the posterior half of the shell. The ventral surface is not very thick; it has a rather wide median groove along its whole length, this groove becoming wider in the anterior part of the last loculus. Two broad ribs separate the median part of the striated area from the two marginal zones which are concave over their whole length and are less distinctly striated. The striae of the central part are weakly convex at the posterior end, more and more rounded near the middle portion, and angular towards the anterior end of the striated area. The limbs of the inner cone are narrow, slightly raised, and form a rounded ridge at the posterior end. In the posterior part the limbs are situated at the margins of the central striated area, but from about one-third of the length of this area on they descend on the marginal zones and are finally situated in the middle of these zones.

The outer cone is narrow, forming two wings at the posterior end which together form a slightly concave calcareous expansion surrounding the inner cone. The spine is gently curved upwards and is without any keels. The dorsal surface of the shell is pinkish, the anterior part of the striated area darker reddish and the last loculus irregularly tinged with red.

In the two shells from Ennûr only the posterior part of the dorsal surface is of a dark reddish colour.

The smallest male specimen from the Gulf of Aden (*c*) has a reddish-purple colour in alcohol. Near the base of the fins, at the margins of the dorsal mantle-surface, there is a series of elongate tubercles; on the outer side of these there is a dark purple band and, next to it or partly on it, a series of small oval or circular cream-coloured patches, often raised as low tubercles.

REMARKS: The shell of this species differs only in one respect from that of *S. burnupi*, the latter having a well-defined mid-dorsal rib. The only animals known of *S. burnupi* are the two female specimens described by Massy (1925, p. 219) as "*Sepia* (*Doratosepion*) *incerta*", unfortunately not in sufficient detail to compare them with *S. trygonina*.

As the type of *S. trygonina* seems to be lost, it is impossible to verify our identification, but we are almost certain that the specimens described above belong to this species which has never been reported since the original description.

Adam (1944, p. 228) advanced the hypothesis that *S. trygonina* might have been the female of *S. elongata*, but this opinion is invalidated if our present identification is correct.

The tentacular club and the hectocotylus resemble those of *S. elongata* very closely (see Adam, 1959, p. 147), but the shell of the latter species has its anterior part much thicker and a different formation of the striated area and of the inner cone (see pl. 21, figs. 132 & 133).

39. ***Sepia elongata*** d'Orbigny, 1845
(Pl. 21, figs. 132 & 133)

Sepia elongata d'Orbigny, 1845, p. 289, pl. 13, figs. 7–10; Férussac & d'Orbigny, 1848, p. 283, pl. 24, figs. 7–10; Adam, 1941*c*, p. 1; 1942, pp. 3, 9; 1944, p. 237; 1959, p. 145, figs. 7 & 8; pl. IV, fig. 5.
Doratosepion elongatum, Rochebrune, p. 97; Adam, 1944, p. 228.

TYPE LOCALITY: Near Cosseir, Red Sea.
GEOGRAPHICAL DISTRIBUTION: Red Sea.

DESCRIPTION: This species is only known from the type shell (pl. 21, figs. 132 & 133) and from a male specimen measuring 97 mm in dorsal mantle-length, described by Adam (1941*c*, p. 1; 1959, p. 145) from the Gulf of Aqaba.

The mantle is elongate, acuminate at the posterior end, and with the dorsal margin slightly projecting. The narrow fins do not reach the posterior end of the body. All the arms are laterally compressed, having outer keels and narrow protective membranes. The suckers are quadriserial, the median ones being slightly larger than the marginal ones. The left ventral arm is hectocotylized in a rather peculiar way. In the middle part of this arm the ventral protective membrane is enlarged on a length of about 4 mm; it attains a width of about 5 mm and has its free margin curved towards the inner side. At the same level the dorsal protective membrane is slightly enlarged. This transformed portion has seven transverse ridges devoid of any suckers. The proximal and distal parts of the arm bear normal suckers which are irregularly arranged.

The small crescent-shaped tentacular club has a well developed swimming-membrane which extends beyond the base of the club; the protective membranes are narrow and separated at the base.

The tentacular suckers are unequal, irregularly arranged, with a series of five big suckers in the middle; the diameter of the latter reaches about two-thirds of the width of the club.

The shell is very elongate, the width measuring 16% of the length, the thickness 11·7%. The dorsal surface is rather flat with a barely indicated median rib which shows a faint median furrow. The spine is strong, rounded, without any keels and nearly straight. The ventral surface is strongly convex in its anterior portion; it has a narrow furrow along its whole length. The inner cone is sharply V-shaped with narrow limbs which are slightly elevated as rounded ridges, situated on the lateral parts of the striated area. The outer cone forms an elongate-oval posterior expansion separating the inner cone from the spine.

Remarks: This species seems only to occur in the Red Sea, the Australian records should be referred to *S. braggi* (see p. 79).

Its tentacular club and hectocotylus closely resemble those of *S. trygonina* (p. 86), but the shell differs in its much thicker ventral surface and in the median part of the striated area, which has a wide groove in *S. trygonina*, and in the limbs of the inner cone—situated on the lateral parts of the striated area in *S. elongata*, and not separating the three zones of the striated area as in *S. trygonina*.

40. ***Sepia mira*** (Cotton, 1931)

Tenuisepia mira Cotton, 1931, p. 546, figs. 7–9; Iredale, 1954, p. 75, pl. V, figs. 7 & 8; Iredale & McMichael, 1962, p. 99.

Type locality: North-West Islet, Capricorn group, Queensland.

Geographical distribution: Queensland; New South Wales.

Description: This species is not represented in the collections of the British Museum. It has been described from a single shell, measuring 55 mm in length, 10·6 mm in width and 4 mm in thickness. It is elongate, sharply rounded at the anterior end, widest at the anterior third, slightly tapering towards the posterior end, but again broadly rounded at the posterior end of the outer cone. The spine is 1·7 mm long; it is straight and rounded, without any keels. The dorsal surface is cream-coloured, without ribs or furrows, and is smooth except for a finely pustulose area near the posterior end; the chitinous margin is narrow. The ventral surface is convex for the greater part of its length, with a very long striated area, devoid of a median groove. If the original drawing is correct, the striated area seems to be composed of a slightly convex central part and two abruptly sloping lateral zones. The inner cone is described as "much reduced". The outer cone, which passes "in front of the spine as a thin, projecting ledge, forms two long wings, without forming the cup-shaped expansion seen in *Sepia braggi* and allied forms of the latter".

Remarks: This species is the type of a new genus *Tenuisepia*, which according to the author shows only affinity with *Decorisepia*, the type of which, *D. rex* Iredale, 1926, "is more than twice as large, much broader, and has the dorsum strongly three-ribbed".

As the animal is unknown, it is impossible for the moment to discuss the question whether these differences can even be considered as being of sub-generic value.

41. ***Sepia orbignyana*** Férussac, 1826
(Pl. 21, figs. 134–137)

Sepia orbigniana Férussac (in d'Orbigny), 1826, p. 156.
Sepia orbignyana, Férussac & d'Orbigny, 1835–1848, p. 273, pl. 5, pl. 27, figs. 1 & 2; Adam, 1952, p. 28, figs. 9 & 10, pl. II, figs. 1 & 2; 1960, p. 467; 1962, p. 14.
Acanthosepion orbignyanum, Rochebrune, 1884, p. 104; Adam, 1944, p. 231.
Sepia (*Parasepia*) *orbignyana*, Naef, 1923, p. 555, figs. 310–314.
Sepia rubens Philippi, 1844, p. 203.
Sepia elegans Vérany, 1851, p. 70, pl. 26, figs. *a–c*; Tiberi, 1880, p. 25; Jeffreys, 1869, p. 140 (*non* Blainville).
Acanthosepion enoplon Rochebrune, 1884, p. 108; Adam, 1944, p. 233.

TYPE LOCALITIES: La Rochelle (France) (*S. orbignyana*); Sicily (*S. rubens*); Mediterranean (*S. enoplon*).

GEOGRAPHICAL DISTRIBUTION: Eastern Atlantic coasts from Arcachon to 17°27′S.; Mediterranean.

DESCRIPTION: We have not revised the material in the collections of the British Museum, but as this species occurs in the southern Atlantic as far south as 17°27′S. (Adam, 1962, p. 13) and perhaps even further, we give a brief description based on Adam's report (1952, p. 28), who examined six ♂ and 17 ♀ specimens[1] collected in 116–430 m depth. Jatta (1896, p. 156) reported it from 30–100 m depth in the Mediterranean, but other authors mentioned it at greater depths: Monaco, 141 m (Joubin, 1920, p. 48), Arcachon, 140 m (Joubin, 1920, p. 48), north of the Arguin Bank, 140 and 235 m (Fischer & Joubin, 1907, p. 333).

The largest male specimen from the southern Atlantic measured 86 mm in dorsal mantle-length; the largest female was 94 mm in dorsal mantle-length.

The mantle is oval, little more than twice as long as broad, its dorsal margin projects strongly in a sharp angle. The sub-equal arms are rather short; those of the male are slightly longer than those of the female, attaining nearly 45% of the mantle-length. All the arms are laterally compressed, with outer keels. The protective membranes are narrow, especially on the left ventral arm of the male. Except for a few suckers at the base, all the arm-suckers are arranged in oblique transverse rows of four, the median ones being wider than the lateral ones. There seems to be a biserial arrangement of the suckers, especially on the tips of the dorsal arms, but in fact this arrangement is quadriserial. The hectocotylus has exactly the same structure as in *S. elegans*, with about a dozen transverse rows of four minute suckers, both the dorsal and the ventral suckers forming a longitudinal zigzag series on more than two-thirds of the arm-length.

The tentacular club closely resembles that of *S. elegans*. Its swimming-membrane extends beyond the base of the club. The latter bears about a hundred suckers, three of these in the middle being much larger than the others and also some of the dorsal ones are somewhat larger than the remaining ones. The suckers are apparently arranged in four to five longitudinal series, but it may be that there are very oblique transverse rows of eight; the biggest suckers belong to the third longitudinal series.

The oval shell is rather acuminate at its anterior end and bluntly rounded at the posterior end which bears a strong spine; this is directed slightly upwards and has a ventral keel (pl. 21, figs. 134–137). The width of the shell measured 32–33% in three males, and 33·5–35% in five females; in a small female of 32 mm length, it measured 43·5%. The thickness of the shell did not show any sexual difference being 9·5–11·5% of shell length.

The dorsal surface of the shell is rose- or orange-coloured, without any median rib but with a faint median-groove[2]. It is finely granulous, with narrow chitinous margins. The ventral surface is slightly convex, with a very faint, narrow, median groove and two large, longitudinal, lateral depressions in the striated area, the striae of which are wavy, being more or less reversed W-shaped in their general outline. The limbs of the inner cone are very narrow and flat. The outer cone forms two distinct posterior wings, united behind the inner cone by a chitinous callus.

The female has a single median receptaculum seminis (spermatheca) in the ventral expansion of the buccal membrane.

REMARKS: The animals of *S. orbignyana* and *S. elegans* seem to be closely related, but the shells are distinctly different.

In the older literature there is much confusion in the nomenclature of these two species (see

[1] In Adam's report (1952, p. 29) the total numbers of specimens were erroneously indicated as 6♀ and 17♂.

[2] In the "Dautzenberg-collection" (Inst. Roy. Sci. Nat. Brussels) there is a shell from unknown locality which resembles *S. orbignyana* in all respects and which has no median groove but a faint rib. On p. 55 we mentioned some shells, which may belong to *S. acuminata*, that possess a median groove instead of a rib.

Adam, 1952, p. 28) which some authors even interpreted as the two sexes of a same species (Forbes & Hanley, 1852, p. 241).

42. ***Sepia australis*** Quoy & Gaimard, 1832
(Pl. 21, figs. 138–142; pl. 45, fig. 270)

Sepia australis Quoy & Gaimard, 1832, p. 70, pl. 5, figs. 3–7; Adam, 1941, p. 117, pl. IV, fig. 5; 1959, p. 149; Voss, 1962*b*, p. 252.
Sepia (*Doratosepion*) *australis*, Massy, 1925, p. 214.
Rhombosepion australe, Rochebrune, 1884, p. 85; Adam, 1944, p. 223.
Rhombosepion australis, Massy, 1927, p. 156.
Sepia capensis d'Orbigny, 1845, p. 283; Férussac & d'Orbigny, 1835–1848, p. 278, pl. 7, figs. 1–3, pl. 12, figs. 7–11, pl. 17, figs. 18 & 19; Thiele, 1920, p. 438, pl. LII, fig. 14, pl. LIII, figs. 1–5.
Rhombosepion capense, Rochebrune, 1884, p. 85; Robson, 1924, p. 641, fig. 24; Adam, 1944, p. 222.
Sepia sinope Gray, 1849, p. 106.

TYPE LOCALITIES: Agulhas Bank (*S. australis*), Cape of Good Hope (*S. capensis*),? China (*S. sinope*).
GEOGRAPHICAL DISTRIBUTION: South Africa[1] (from Dassen Island to Port Alfred); Red Sea.

MATERIAL:

a. ? China; 1 shell (type of *S. sinope*); B.M. 196385W.
b. Port Elizabeth (Ponsonby); B.M. 1892.1.19.10; 1 shell (figured by Smith, 1916, pl. 2, fig. 9).
c. Port Elizabeth (Ponsonby); B.M. 1892.12.8.1; 1 broken shell.
d. Cape Town (Gilchrist, Sta. 20); B.M. 1924.9.9.61(det. Robson as *S. capense*); 3 ♂ (L_M = 53, 54 and 55 mm).
e. Cape Town (Gilchrist, Sta. 9); B.M.1924.9.9.62–69 (det. Robson as *S. capense*); 6 ♀, 2 ♂.
f. Cape Town; 1924.9.9.62–71. (det. Robson as *Rhombosepion capense*); 3 shells (poor condition).
g. Cape St. Blaize, N 36 miles (P.F. 1866, No. 1307), shrimp trawl, 54 fms., sand and shingle; B.M. 1926.10.20.2–3. (det. Massy, 1927); 2 ♀ (L_M = 44 and 38 mm).
h. Off Sebastian Bay, Cape Infanta, E. by N.$\frac{3}{4}$ N.4$\frac{3}{4}$ miles (P.F. 6051, No. 1260/23), shrimp trawl, 35 fms., mud; B.M. 1926.10.20.4. (det. Massy, 1927); 1 ♂ (L_M = 34 mm).
i. Gericke Point, N. by E.$\frac{1}{4}$ E.5 miles (P.F. 10404, No. 1265), shrimp trawl, 35 fms., fine sand; B.M. 1926.10.20.6. (det. Massy, 1927); 1 ♀ (L_M = 39 mm).
j. Cape Infanta; NE. by N.19 miles (P.F. 8046, No. 1255), shrimp trawl, 46 fms., sand and shingle; B.M. 1926.10.20.9. (det. Massy, 1927); 1 ♂ (L_M = 36 mm).
k. Cape Point Lighthouse, W.$\frac{1}{4}$ S.9$\frac{1}{2}$ miles (P.F. 15.577), shrimp trawl, 32 fms., fine sand; B.M. 1926.10.20.10–11. (det. Massy, 1927); 2 ♂ (L_M = 29 and 26 mm).
l. Off Mossel Bay, 34°14′S., 22°23′E. (P.F. 99), shrimp trawl, 36 fms., mud; B.M. 1926.10.20.22. (det. Massy, 1927); 1 ♂ (L_M = 36 mm).
m. Cape St. Blaize (S. Afr. Mus.); B.M. 1926.10.20.49; 2 shells (poor condition).
n. Grahamstown, Natal (Tomlin); B.M. 1952.11.21.31; 1 shell (pl. 21, figs. 138–139).
o. S. African Coast, 31°43′S., 16°13′E., 250 fms., 9.vi.1947 (Afr.716H, J.H. Day); B.M. 1958.8.20. 4; 1 ♀.

[1] According to Barnard (*in litt.*) the S. African Museum has specimens from off Cape Natal (Durban), 54 fms.

MEASUREMENTS:

ANIMALS (IN % OF MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
e	♂	55	82	42	22	40	84	11	35
	♂	48	83	44	23	42	79	10·5	31
	♀	55	84	44	22	40	80	11	29
	♀	53	81	45	21	38	81	11	26
	♀	53	83	45	23	40	76	7·5	28
	♀	48	85	50	23	42	79	10·5	31
	♀	41	83	49	24	44	78	12	27
	♀	40	85	47	23	45	80	12·5	27
o	♀	54	82	43	20	37	83	11	26

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
e	♂	55	33	31	33	91	11	2·18	2·0
	♂	48	31	33	35	83	12·5	2·30	1·88
	♀	55	29	31	29	91	12·5	1·64	2·0
	♀	53	28	28	28	85	12	1·70	2·07
	♀	53	28	28	30	76	12	1·70	2·07
	♀	48	31	33	33	104	13·5	1·88	2·30
	♀	41	27	27	27	98	12	1·95	2·20
	♀	40	27	27	27	100	15	2·00	2·50
o	♀	54	28	28	30	83	14	1·85	2·22

SHELLS (IN % OF SHELL-LENGTH)

Loc.	L. in mm	W.	Th.	Str.z.	Spine	Observations
n	56·5	29	6·5	74	3·5	pl. 21, figs. 138 & 139
b	42	29	7·6	67	3·6	

DESCRIPTION: The specimens from Cape Town (*e*), which Robson (1924, p. 641) described as *Rhombosepion capense*, are in rather good condition. The body is acuminate at the dorsal mantle-margin and at the posterior end. The fins begin several millimetres behind the mantle-margin and extend beyond the posterior end of the mantle where they are widely separated. The mantle is darkly pigmented on the ventral side, especially near the fins; the latter are cream-coloured each with a thick orange ridge at its dorsal base. The arms are laterally compressed and keeled on their outer sides. The suckers are quadriserial, the median ones being much larger than the marginals. The interbrachial web is rather shallow and sub-equal between the dorsal, dorso-lateral and ventro-lateral arms, and more reduced between the ventro-lateral and ventral ones. The tentacular club is short; the swimming-membrane extends slightly beyond the base of the club (pl. 45, fig. 270). The suckers are arranged in about five longitudinal rows, those of the middle row being much larger than the other ones. The narrow protective membranes are separated at the base.

In the male, the difference in size between the median and marginal arm-suckers is more pronounced than in the female. The left ventral arm is hectocotylized and has at its base two pairs of normal suckers, followed by 13 slightly alternate pairs of smaller ones; the first two dorsal suckers are larger than the ventral ones, the remaining suckers are minute and widely separated. The transformed portion is slightly more than half the arm-length; the distal part is normal, bearing about 10 transverse series of four suckers.

All the distal suckers of the arms have the distal margins of their chitinous rings each armed with a dozen long pointed teeth. On the dorsal and dorso-lateral arms, the proximal suckers have smooth rings, while on the ventro-lateral and ventral arms these suckers are armed with short teeth.

The female has the distal suckers irregularly dentate with blunt, more or less fused teeth but the proximal ones have smooth rings. The buccal membrane possesses a strongly-developed, heavily wrinkled, ventral pad.

The shell is broadest in its anterior third; it is regularly acuminate towards the posterior end, which bears a well-developed spine. The latter has a dorsal keel which extends for a short distance as a laterally-flattened high keel on the posterior part of the shell (pl. 21, figs. 138 and 139). The dorsal surface is finely tuberculate, with a well-defined median rib.

The ventral surface is rather flat with a narrow median groove and two lateral, somewhat wider, grooves. The striated zone is long and the striae wavy due to the grooves. The limbs of the inner cone are very narrow and are slightly raised. The outer cone is not sufficiently well preserved to define but it also seems to be narrow.

REMARKS: In his original description of *Sepia sinope*, Gray (1849, p. 106) synonymized this species, which was reported from China, with *S. australis*. Unfortunately the posterior end of the type-specimen (pl. 21, figs. 141 & 142) is missing, but we do not have the slightest doubt that it belongs to the latter species. The specimen from Manila, mentioned by Voss (1962, p. 3) as being *S. sinope*, belongs in fact to *S. pharaonis* (see p. 26).

Several authors (Gray, 1849, p. 110; Whitelegge, 1889, p. 282; Tate & May, 1901, p. 351; Chapman 1912, p. 24) have reported this species from Australia under the name *Sepia capensis*, but according to Robson (1924, p. 643) the Australian form is very distinct from the South African. In any case, the specimens, mentioned by Gray (1849, p. 110) from Sydney and from "Australia" belong to *S. cultrata* Hoyle (see p. 59). According to Iredale (1954, p. 70) the specimen from Torquay (Victoria) identified by Chapman (1912, p. 24) as being *Sepia capensis* is, in fact, *Decorisepia rex* Iredale.

43. ***Sepia sulcata*** Hoyle, 1885
(Pl. 46, fig. 275)

Sepia sulcata Hoyle, 1885, p. 192; 1885*a*, p. 296; 1886, p. 137, pl. XIX, figs. 1–13; Adam, 1939*c*, p. 41.

TYPE LOCALITY: off the Ki Islands, Arafura Sea, 5°49′15″S.–132°14′15″E., 140 fms. blue mud.

MATERIAL:

a. *Holotype*: Challenger Sta. 192, 26.ix.1874; B.M. 1889.4.24.77; 1 ♂.

MEASUREMENTS:

ANIMAL (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a	♂	53	87	47	26	43	85	9·5	28

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	♂	53	28	28	30	114	9·5	1·3	0·5

DESCRIPTION: The body is broadest at the mantle-opening, tapering gradually towards the acuminate posterior end; the dorsal mantle-margin projects strongly, nearly reaching the anterior level of the eyes.

The sub-equal arms are all laterally compressed and strongly keeled on the outer sides (including the dorsal ones).

The tentacular club is small with a broad swimming-membrane, extending beyond the base for about half the length of the club (pl. 46, fig. 275). The dorsal protective membrane is rather wide and separated at the base from the ventral one. The minute, sub-equal suckers seem to form six longitudinal series, but are really arranged in oblique transverse series of eight.

The left ventral arm is hectocotylized, its basal three-fourths being transformed, there being a series of about 24 small suckers on both sides; both series are separated by a convex fleshy ridge.

On the dorsal arms the suckers are biserial, but on the other arms it is difficult to decide if they are biserial or quadriserial; this may be due to contraction on preservation.

Unfortunately, the shell is badly damaged and its posterior portion lacking. It is broadly oval, acuminate at both ends, especially at the posterior one. The dorsal surface shows three flat, rounded ribs, separated by wide grooves.

The chitinous margins seem to be wide, but this may be due to a decalcification. In his original description, Hoyle (1886, p. 138) mentions "a faint linear ridge in the middle line posteriorly, about 3 mm. long, and terminating 2 mm. from the base of the spine". The latter was present, but, as it had been broken off, it could not be described.

The ventral surface is flat with three wide, shallow, grooves over the whole length; these are separated by two broad, low ribs. The striated area shows the striae to be regularly convex in its posterior portion and wavy in the anterior part. It is flanked by two narrow, smooth, marginal zones. The limbs of the inner cone are narrow, raised as a thin ledge towards the posterior end (which is lacking).

Remarks: According to Hoyle (1886, p. 139) "*Sepia elegans*, d'Orb., has the keel but no spine, while an unnamed specimen from the Cape in the Copenhagen Museum has a stronger keel reaching quite up to the spine, which is larger and thinner than in this specimen". In fact, the shell of *Sepia sulcata* closely resembles that of *S. australis* Quoy & Gaimard, 1832, but the animal of the latter species has quadriserial arm-suckers and the hectocotylus and the tentacular club are quite different.

44. ***Sepia omani*** sp. nov.
(Pl. 22, figs. 143–147; pl. 41, figs. 242–244)

Holotype: John Murray Exp. Sta. 75, 25°10′48″N., 56°47′30″E. to 25°09′48″N., 56°47′30″E., Gulf of Oman, 201 m, 28.xi.1933; 1 ♂ (M.L.d. = 62 mm); B.M. 1963107W.
Paratypes: Idem: 7 ♂, 6 ♀; B.M. 1963108–114W.

Measurements:

Animals (in % of dorsal mantle-length)

Sex	M. L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
♂	62	81	—	26	40	81	8	32
♂	64	70	—	36	44	—	—	41
♂	57	88	—	30	47	—	16	40
♂	59	—	—	22	38	—	—	32
♀	66	76	—	27	41	—	10·5	33
♀	66	80	53	24	41	—	7·5	33
♀	54	80	50	35	46	—	—	28

Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
♂	62	32	35	37	89	13	1·3	2·4
♂	64	39	39	41	125	15·5	1·25	3·6
♂	57	37	35	39	130	17·5	1·4	3·5
♂	59	30	30	32	100	13	1·0	2·4
♀	66	29	30	36	98	15	1·35	3·0
♀	66	30	29	35	114	13·5	1·35	3·0
♀	54	28	30	35	102	15	1·1	2·4

SHELLS (IN % OF SHELL-LENGTH)

Sex	L. in mm	W.	Th.	Str.z.	Spine	Observations
♂	62	26	10·5	53	6·5	Holotype, pl. 22, figs. 143–145
♂	64	25	9·5	50	7·8	animal distorted
♂	63	25	10·5	51	7·1	M.L.d. = 64 mm
♂	59	27	10·0	52	8·5	M.L.d. = 54 mm
♂	57	28	12·0	54	5·3	M.L.d. = 57 mm
♂	57	26	9·5	47	8·8	animal distorted
♂	54	26	9·5	50	7·4	animal distorted
♀	69	25	10	51	5·8	M.L.d. = 66 mm
♀	66	26	11	49	6·1	M.L.d. = 66 mm

DESCRIPTION: The body is rather broad, the dorsal mantle-margin projects forward strongly even beyond the mid-level of the eyes; the ventral margin is slightly emarginate. The fins start a few millimetres behind the mantle-margin. At the posterior end they extend beyond the mantle but remain separate.

All the arms are laterally compressed, the dorsal ones are rounded on the outer sides, the lateral ones are keeled on the ventral margins of the outer sides and the ventral ones have strong swimming-membranes. The web is very high between the dorsal arms and between the dorsal and dorso-lateral ones, reaching a level of about one-third to one-half the arm-length. The suckers are rather globular and are quadriserial throughout the whole length of the arms. On the proximal part of the arms the lateral suckers are smaller than the median ones, at the distal tips the lateral ones are biggest, except on the ventral arms. Their chitinous rings are smooth.

The tentacular stem is rounded in section and the club is short and broad. The well developed swimming-membrane is situated on the dorsal side and slightly exceeds the club in length. The sucker-bearing surface is mostly separated from the stem by a deep groove between the dorsal protective membrane and the tentacle itself (pl. 41, figs. 242–244). The protective membranes are not very wide; they are separated at the base of the club and do not continue down the stem. The tentacular suckers are arranged in very oblique transverse series of eight, the third sucker of the second to fourth or fifth series being larger than the other ones. The chitinous rings of the small distal suckers are finely dentate.

The buccal membrane of the female has the ventral patch expanded ventrally.

The left ventral arm of the male is hectocotylized; it has two groups of four suckers at the base, followed by a transformed portion (of about two-fifths of the arm length (9 mm)) which is slightly wider, with transverse ridges and nine or ten transverse rows of minute suckers; the two ventral series are close together and the dorsal ones are more widely spaced. The distal part of this arm has normal-sized suckers.

The shell is elongate and acuminate at both ends (pl. 22, figs. 143–147). The dorsal surface is rugose, being more strongly so in its anterior part and near the lateral margins of the posterior part and shows three ribs separated by two grooves. The ventral surface is thickest at the anterior end of

the striated area which is convex with a narrow median groove; in the anterior portion of the last loculus this groove is wider. The striae are wavy, being nearly straight in the middle, but convex in the lateral parts. There is a very narrow smooth zone on both sides between the striated area and the outer cone. The inner cone has very narrow limbs which are situated on the margins of the striated area or on the smooth zones. Along the posterior half of the striated area these limbs are raised as narrow rounded ridges which form a V-shaped posterior ledge, surrounding an excavation. From this part radiate irregular calcareous ribs into the wings of the chitinous outer cone. The latter is very narrow but forms two posterior wings which surround the inner cone.[1]

The straight or slightly curved spine is directed upwards; it is laterally compressed and possesses a distinct dorsal keel and a still more pronounced ventral keel.

Remarks and relationship: The animal of this species resembles that of *S. prashadi* very closely, especially as regards the tentacular club which shows only minor differences. The big suckers of the third longitudinal series attain a much greater size in *S. prashadi* as far as the material from the Gulf of Oman is concerned (pl. 41, fig. 245), but specimens from the Gulf of Suez show them of about the same size as in *S. omani*. In the latter species the distal suckers are more numerous. The hectocotylus is of the same type but is relatively longer in *S. prashadi*. The shell of these species is completely different.

The posterior part of the inner cone with its radiating, calcareous ribs extending over the chitinous outer cone is exactly of the same type as in *S. arabica* (pl. 23, figs. 152–155), but the latter has no spine, only a dorsal keel on the posterior part of the dorsal surface.

The shell of *S. omani* resembles that of *S. kobiensis* in its general shape, but it is relatively broader. *S. kobiensis* has the mid-dorsal rib less developed and it is not flanked by deep grooves; the sculpture is more delicate and exhibits longitudinal lines of tubercles that are absent in *S. omani*. The outline of the striae of the ventral surface is different, the inner cone is rather similar, but *S. kobiensis* lacks the radiating calcareous ridges. The outer cone has a cup-shaped posterior portion which is calcareous in *S. kobiensis*, but it is chitinous and expanded in *S. omani*. The spine is not keeled in *S. kobiensis*.

S. braggi shows the calcareous ridges radiating from the inner cone, but they are less pronounced. The limbs of the inner cone are situated more at the base of the outer cone in *S. omani*, whereas in *S. braggi* and *S. kobiensis* they occupy a higher position at the margins of the striated area.

The inner cone has the same structure and general form as in *S. murrayi*, but in this species the posterior ledge is slightly more raised and sharp-edged.

45. ***Sepia elegans*** de Blainville, 1827
(Pl. 23, figs. 148–151)

Sepia elegans Blainville, 1827, p. 284; Férussac & d'Orbigny, 1835–1848, p. 280, pl. 8, figs. 1–5, pl. 27, figs. 3–6; Adam, 1952, p. 22, figs. 7 & 8, pl. III, figs. 1 & 2; 1960, p. 466; 1962, p. 13.
Rhombosepion elegans, Rochebrune, 1884, p. 87; Adam, 1944, p. 223.
Sepia (*Parasepia*) *elegans*, Naef, 1923, p. 560, figs. 315–320.
Parasepia (*Sepia*) *elegans*, Robson, 1926, p. 163; 1931, p. 278.
Sepia rupellaria Férussac & d'Orbigny, 1835–1848, p. 274, pl. 3, figs. 10–13.
Rhombosepion rupellarium, Rochebrune, 1884, p. 83, pl. III, fig. 3; Adam, 1944, p. 222.
? *Sepia biserialis* Blainville, 1827, p. 284.
Sepia bisserialis Vérany, 1851, p. 73, pl. 26, figs. *f–k*.
Sepia italica Risso, 1854, p. 13, pl. V, figs. 1 & 2.

[1] In the photographs (pl. 22, figs. 143 and 144) the posterior wings of the outer cone appear shrunken because of the drying-up of the shell.

TYPE LOCALITIES: Sicily (*S. elegans*); Mediterranean (*S. bisserialis* and *S. italica*); Island of Noirmoutiers and La Rochelle (*S. rupellaria*).

GEOGRAPHICAL DISTRIBUTION: Eastern Atlantic coasts, from the South of England to 16°36′S.; Mediterranean.

DESCRIPTION: We have not made a special study of the material in the collections of the British Museum, but we wish to give a brief description of this species, based on that of Adam (1952, p. 22) who reported it for the first time from the Southern Atlantic, because it may occur even further south.

It is a sub-littoral species, which has been collected in the Southern Atlantic between 80 and 430 m depth; in the Northern Atlantic it has been reported in lesser depths, up to 50 m, but it has never been found at the surface, although the shells drift as far as the beaches of the North Sea.

Adam's description was based on 26 ♂, 68 ♀ and 16 juvenile specimens. The longest male had a dorsal mantle-length of 72 mm and the largest female, 89 mm; females of a dorsal mantle-length of 59 mm are sexually mature. There is no noteworthy difference in the relative measurements of the two sexes.

The mantle is elongate oval, more than twice as long as wide and the dorsal margin projects forward strongly in a sharp angle; the ventral margin is slightly emarginate.

The sub-equal arms are short, being less than half the mantle-length. All the arms are laterally compressed and keeled on the outer sides. In the female the dorsal and lateral arms have about five pairs of suckers at the base of each arm and the ventral ones have two to four pairs; on the remaining parts of the arms the suckers are arranged in very oblique transverse rows of four, the median ones of which are slightly larger than the lateral ones. This arrangement is not always distinct and apparently the suckers are in three or in two longitudinal series, but the difference in size between the median and lateral suckers permits us to recognize the true arrangement. In the male, the dorsal and lateral arms each possess about 10 pairs of suckers proximally; the distal part shows the quadriserial arrangement; the right ventral arm does not differ from that of the female. The left ventral arm is hectocotylized on more than two-thirds of its length. There are a few normal suckers proximally, followed by 9 to 11 transverse rows of four minute suckers, the dorsal and the ventral suckers each forming a longitudinal zigzag series, both series being widely spaced. The distal tip of the arm has the suckers normally arranged in oblique rows of four.

The short, broadly-oval, tentacular club bears about 80 suckers, two or three of which in the middle are very big and may exceed the arm-suckers in size. On the dorsal side of these big suckers there are a few other rather large suckers. The very big suckers are probably the third ones of very oblique transverse rows of eight, but it is not possible to make out the exact arrangement.

The female possesses a single, median receptaculum seminis (spermatheca) in the ventral part of its buccal membrane.

The shell is elongate-oval and acuminate at both ends (pl. 23, figs. 148–151). In the males its width is 27·5–32·5% of the length, in the females 29·5–35%; the thickness is 8·5–11% of the length in the males and 8·5–13% in the females. The striated area is always greater than half the shell-length and may be as much as 72% of the total length of the shell. The convex dorsal surface has a distinct median rib, flanked by two shallow grooves; it is finely granulous in the calcareous portion and the chitinous lateral margins are broad. The posterior end has no spine, only a short rugose, calcareous keel. The ventral surface is faintly convex with a narrow, median groove along its whole length. The striae of the striated area are regularly convex. The inner cone has very narrow limbs, raised as rounded ridges which enclose a small depression at their posterior end. At its posterior end the rather narrow outer cone forms two distinct chitinous wings, united behind the inner cone by a small, calcareous, very rugose ledge.

REMARKS: This species rather resembles *S. australis*. The latter differs in the arrangement of the arm-suckers, in its slightly different tentacular club and hectocotylus. The shells of both species

possess a posterior keel, but *S. australis* also has a well-developed spine, a flatter ventral surface with three grooves, and a much narrower outer cone.

According to d'Orbigny (1845, p. 300), *Sepia biserialis* Blainville is a synonym of *Sepioteuthis sepioidea* Blainville but this seems to be very doubtful and most probably the former species is identical with *S. elegans* Blainville.

46. ***Sepia arabica*** Massy, 1916
(Pl. 23, figs. 152–155; pl. 46, fig. 278)

Sepia arabica Massy, 1916, p. 228, pl. XXIII, figs. 1–5; pl. XXIV, fig. 10.

TYPE LOCALITIES: Laccadive Sea, 11°14′30″N., 74°57′15″E., 68–148 fms.; Persian Gulf, 26°20′N., 53°54′E., 54 fms.

GEOGRAPHICAL DISTRIBUTION: Indian Ocean; Red Sea (Adam, ms.)

MATERIAL:

a. John Murray Exp. Sta. 194, 13°16′00″N., 46°20′24″E. to 13°16′36″N., 46°14′00″E., Gulf of Aden, 220m, 7.v.1934; 1 ♂. B.M. 196396W.

MEASUREMENTS:

ANIMAL (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a	♂	67	89	46	19	37	—	15	28

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	♂	67	30	37	34	112	9	0·3	0·6

SHELL (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Observations
a	♂	65	14·5	11·5	—	pl. 23, figs. 152–155

DESCRIPTION: The following description applies to the male which has not previously been described, the original material consisted of two female specimens.

The whole surface (in preservative) is covered with red or reddish-purple chromatophores which are crowded together on the dorsal surface of the mantle, head and arms; they are less crowded on the ventral surface giving this side a paler appearance. There are also more dense purplish patches over the eyes, distributed irregularly along the dorsal surface of the mantle and on the fins. There are 10 to 12 of these patches, roughly circular in shape, on the base of the posterior half of each fin; they recall the ornamentation which is found in *Sepiella ornata*. Just median to the row of dark patches there is, on both sides, a series of elongate warts and the spaces between the patches may be raised as pale circular tubercles.

The body is similar in general appearance to Massy's figures but our specimen is more slender and more acuminate at the posterior end.

The fins begin about 5–6 mm from the margin of the mantle and are widest near the posterior end of the body. The dorsal mantle-margin projects forward to a point between the eyes (in Massy's figure it is only slightly convex). Ventrally the margin is only slightly emarginate.

The head is somewhat narrower than the mantle opening; it is rather flattened and it has large eyes and a broad, blunt funnel. There is a web between some of the arms, this being best developed between the lateral arms; it is progressively less developed between the ventro-lateral and ventral arms, between the dorsal ones, and between the dorsal and the dorso-lateral ones. It appears to be absent between the ventral arms.

The dorsal arms are laterally compressed and rounded on the outer sides. The dorso-lateral arms are also compressed, their outer sides are bluntly rounded with rounded keels on the ventral margins. The ventro-lateral arms are much like the dorso-lateral ones but each has a thick, low swimming-membrane on the ventral margin of the outer side. The ventral arms are broadly rounded on the ventral side each with a very strong swimming-membrane on its outer margin.

All the arms being strongly compressed, their sucker-bearing surfaces are narrow with broad protective membranes. The suckers are small and widely spaced. They seem to be biserial, especially at the base, but in fact they are arranged in an oblique series of four, the outer ones often being slightly smaller than the inner ones. They appear to be arranged in alternating pairs, but are, as Massy (1916, p. 229) described, "in a slanting series of four in a row, except the proximal ones which generally consist of two and three suckers each".

The tentacles are very slender with small crescent-shaped clubs. The tentacular stem is triangular in cross-section, with blunt angles, the inner surface is flat with the protective membranes of the club continuing as low ridges. The club has a well developed swimming-membrane on its dorsal side and this is slightly longer than the club (pl. 46, fig. 278). The dorsal protective membrane is very broad and is as wide as the sucker-bearing surface. The suckers are sub-equal, arranged in about five or six longitudinal series.

The left ventral arm is hectocotylized, its sucker-bearing surface being folded together and nearly completely covered by the protective membranes. We wonder if this can be interpreted as a hectocotylization as the right ventral arm shows something of the same phenomenon.

The shell is long and narrow, rounded anteriorly and more or less pointed behind (pl. 23, figs. 152–155). The posterior portion is bent ventrally in a graceful curve. The dorsal surface has a broad, calcareous, median rib with a coarse, irregularly granulated surface. On either side of this rib, the two lateral surfaces are completely chitinized and faintly striated along their length. There is no sign of an apical spine but the posterior end of the dorsal surface bears a chitinous keel which begins at the same level as the lateral wings.

The ventral surface possesses a median groove, extending for the whole of its length and widening slightly anteriorly. At its posterior margin the last loculus is limited by the characteristic V-shaped striae described by Massy; these constitute the most distinctive feature of the shell.

It attains its greatest thickness in the posterior part of the last loculus, where the surface is strongly convex. The last loculus becomes flattened towards the anterior end. The striated area is also strongly convex except at its posterior end where it is nearly flat. This striated area is separated from the outer cone by a smooth flat zone lying between the outer cone and the branches of the inner cone. The latter has two elevated, sharply-keeled limbs extending to about half the length of the shell and separating the striated area from the flat, smooth zones.

The outer cone is narrow but slightly enlarged in its posterior part where it surrounds the inner cone. From the posterior end of the latter radiate a number of sharp-keeled ridges, calcareous in their central part and chitinous towards the margin of the outer cone, which forms two narrow wings, united posteriorly.

Remarks: Up to the present the shell of *S. arabica* was imperfectly known as the posterior part was lacking in the original material.

This species differs from all other species in the absence of a spine, the presence of a posterior keel, its elongated form and in the calcareous ridges radiating from the posterior part of the inner cone.

47. *Sepia dollfusi* Adam, 1941
(Pl. 24, figs. 156–158; pl. 41, fig. 237)

Sepia dollfusi Adam, 1941*b*, p. 12, pl. II, fig. 3; 1942, pp. 3, 8: 1959, p. 138, fig. 5; pl. IV, fig. 4; pl. VI, figs. 4 & 5; pl. VII.
Sepia gibbosa Issel, 1869, p. 238 (pars) (*non* d'Orbigny).
Sepia lefebrei, Hoyle, 1907, p. 39, figs. 1–7; ? Wülker, 1920, p. 53 (*non* d'Orbigny).
Lophosepion lefebrei, Robson, 1927, p. 322 (pars) (*non* d'Orbigny).
Lophiosepion lefebrei, Gruvel, 1936, p. 184 (*non* d'Orbigny).
Sepia rouxi Hoyle, 1907, p. 42 (pars) (*non* Férussac & d'Orbigny).

TYPE LOCALITY: Périm.
GEOGRAPHICAL DISTRIBUTION: Red Sea; Suez Canal.
MATERIAL:

a. Suez Canal (Fox); B.M. 1926.4.8.1. (det. Robson as *Lophosepion lefebrei*); 1 ♂.
b. Suez, Nov., 1904 (purchased from fisherman; W.E.H. No. 1076–1077); B.M. 1947.5.5.44–45. (det. Hoyle as *Sepia rouxi*); 2 ♂.
c. Suez, mud flats, 2-3 fms. (W.E.H. No. 1097); B.M. 1947.5.5.46. (det. Hoyle as *Sepia lefebrei*); 1 ♂.
d. East of Suez (Pres. Air Commodore T. C. Morton); B.M. 1947.12.3.2; 1 ♀.

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
b	♂	58	91	62	31	48	—	—	—
d	♀	55	88	49	33	49	—	—	40
a	♂	50	90	54	40	54	100	20	46
c	♂	40	90	50	30	52	—	12·5	40

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
b	♂	58	—	—	—	164	26	1·72	1·72
d	♀	55	38	42	44	136	31	1·82	2·0
a	♂	50	46	46	50	130	38	2·0	2·6
c	♂	40	45	42	47	135	32	2·0	2·0

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Observations
b	♂	58	38	18	55	
d	♀	54	40	18·5	57	
a	♂	48	42	16·5	58	pl. 24, figs. 156–158

DESCRIPTION: The male specimen, which Robson (1927, p. 322) considered to be *Lophosepion lefebrei*, has a broad oval mantle and is dark slate-coloured on the dorsal side, except for the fins; it is yellowish-brown on the ventral side with a series of dark spots at the base of the fins. The mantle-margin is slightly convex or angular at the dorsal side and nearly straight on the ventral one. The fins extend anteriorly beyond the mantle-margin and also beyond the posterior end of the body. The head is broad with large rounded eyes. At the base of the fins there is a series of elongate tubercles. On the dorsal surface of the head there are three pairs of narrow, lighter-coloured fleshy ridges, extending from the posterior margin of the head up to about the basal half of the dorsal and

lateral arms, but not continuous with the outer keels or swimming-membranes. The ridges from the dorsal arms are nearly parallel between the eyes, being about 4 mm apart at the mid-level of the eyes; those from the dorso-lateral arms are at about 7 mm from the first ones; those from the ventro-lateral arms at about 4 mm from the second ones and situated at the dorsal margin of the pupils. The ridge coming from the ventro-lateral arms bifurcates in front of the eye, the lower branch going below the ventral margin of the pupil.

All the arms are laterally compressed and keeled on their outer sides. The protective membranes are rather narrow; the suckers are quadriserial with their chitinous rings irregularly and bluntly toothed at their distal margins.

The left ventral arm is hectocotylized with about five transverse rows of normal basal suckers followed by about eight rows of smaller ones, the dorsal suckers being smaller than the ventral ones; the rest of the arm is normal.

The interbrachial web is low and sub-equal except between the ventral arms, where it is absent.

The left ventro-lateral tip of the buccal membrane bears a minute sucker.

The tentacular stem is roughly triangular in cross-section being flattened on its inner surface and rounded on the outer one.

The swimming-membrane is not very broad being only slightly longer than the club. The protective membranes are narrow and separated at the base of the club; they continue down the stem as thin membraneous ridges. The sub-equal suckers are arranged in oblique transverse rows of eight; in the middle of the club the suckers of the fourth longitudinal series are slightly larger (pl. 41, fig. 237). Their rings are denticulate all round with numerous small, more or less, blunt teeth.

The shell is broadly oval, rounded at both ends, without any spine or knob (pl. 24, figs. 156–158). Its dorsal surface is regularly convex with only a faint indication of a median rib and nearly the whole surface is covered with a fine reticulate granulation; the chitinous margins are very narrow. The ventral surface is keeled in the middle along nearly the whole length of the striated zone, except in its flat posterior part. The rounded keel has a very narrow groove in the middle. On both sides of the median keel the striated zone is concave and on both sides the striated zone is separated from the outer cone by a very narrow smooth marginal area. The last loculus is convex in its posterior central part, flattening out towards the anterior and lateral margins. The inner cone reaches to about two-thirds of the length of the striated zone; its limbs are broad and completely fused to the outer cone and to the smooth margins of the striated zone and its posterior part is very slightly raised as a flat ledge. The rather broad outer cone completely surrounds the inner one and nearly everywhere has the same width.

The female specimen (*d*) has a minute sucker on some of the tips of the buccal membrane. The ventral portion of the latter is ventrally expanded.

Remarks: In his original description of *Sepia dollfusi*, Adam (1941*b*, p. 13) was unable from Hoyle's description (1907, p. 39) of the shell to state whether this specimen belonged to *Sepia gibba* or to *Sepia dollfusi*, but pointed out that the description of the animal agreed with that of the latter species. In the same paper Hoyle (1907, p. 42) recorded four males of *Sepia rouxi* from Suez. Three of these are in the British Museum collection. One of them (Hoyle's No. 1075), is undoubtedly *Sepia rouxi* (= *Sepia pharaonis*, see p. 22), but on examination of the cuttle-bone, the other two prove to be *Sepia dollfusi*, as well as the specimen mentioned above which Hoyle (1907, p. 39) referred to as *Sepia lefebrei*.

Adam (1941, p. 13) referred the female specimen, described by Robson (1927, p. 322) as *Lophosepion lefebrei*, to *Sepia dollfusi*, but he supposed that the two shells (Brit. Mus. *A* and *B*) might belong to *Sepia gibba*. These views are confirmed from an examination of the material.

48. *Sepia gibba* Ehrenberg, 1831
(Pl. 25, figs. 159–161)

Sepia gibba Ehrenberg, 1831; Adam, 1941*b*, p. 7, pl. II, fig. 2; 1942, p. 8; 1944, p. 236; 1959, p. 137, pl. VI, figs. 1–3.
Sepia gibbosa d'Orbigny, 1845, p. 287; Férussac & d'Orbigny, 1848, p. 281; Issel, 1869, p. 238 (pars).
Lophosepion gibbosum, Rochebrune, 1884, p. 91; Adam, 1944, p. 225.
Sepia lefebrei d'Orbigny, 1845, p. 288, pl. 13, figs. 5 & 6; Férussac & d'Orbigny, 1848, p. 282, pl. 24, figs. 1–6; ? Weindl, 1912, p. 270.
Lophosepion lefebrei, Rochebrune, 1884, p. 90, pl. IV, fig. 2; Robson, 1927, p. 322 (pars); Adam, 1944, p. 225.

TYPE LOCALITIES: Red Sea.
GEOGRAPHICAL DISTRIBUTION: Red Sea.
MATERIAL:

a. Red Sea (McAndrew); B.M. 1869.6.14.2; 2 shells. (det. Robson as *Lophosepion lefebrei*.)
b. Eylath (Sta. E. 60/31; Hebrew University), 4.v.1960; 1 ♂.
c. Eylath (Sta. E. 60/62,1(2); Hebrew University), 5.ix.1960, 3 feet; 3 ♂, 3 ♀.
d. Eylath (Sta. E. 60/62, 2(2); Hebrew University), 5.ix.1960, 3 feet; 10 juv. sp. (M.L.d. = 9·5; 10; 10; 11; 12·5; 16; 18; 18·5; 23·5 and 24 mm).

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
b	♂	39	90	56	23	51	92	15·5	41
c	♂	62	87	47	24	40	92	9·5	44
	♂	34	91	59	32	48	—	—	32
	♂	27	81	55	33	48	92	15	30
	♀	47	85	54	32	46	92	13	32
	♀	36·5	85	57	30	49	93	14	33
	♀	23	89	59	35	56	93	17	35

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
b	♂	39	41	41	51	—	22	1·8	1·4
c	♂	62	44	44	42	—	26	2·1	1·8
	♂	34	32	32	35	132	23	1·5	1·5
	♂	27	30	30	33	148	26	1·8	1·8
	♀	47	32	34	34	106	27·5	1·3	1·9
	♀	36·5	33	33	36	124	27·5	1·4	1·6
	♀	23	35	35	39	130	30	1·7	1·7

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	W.P.	Str.z.	L. loc.	M.L.d. in mm
d	♂	22	45	27	13·5	45	50	24
	♀	22·5	47	—	—	—	—	23·5
	juv.	17·5	51	23	15·5	43	49	18·5
	juv.	16	53	23	15	47	47	18
	juv.	15·5	50	19·5	15·5	45	42	16
	juv.	10·7	56	17	14	47	47	11
b	♂	36·5	40	27·5	15	52	38	39
c	♂	59	35·5	26	17	—	—	62
	♂	33	39	26	15	38	50	34
	♂	26	42	24·5	15·5	37	48	27
	♀	45	40	28	19	44	44	47
	♀	35	41	27	17	37	49	36·5
	♀	22	50	28	18	39	45	23

DESCRIPTION: Both the shells in the British Museum are in rather poor condition but belong without any doubt to *Sepia gibba*.

The only known animal was described by Rochebrune (1884, p. 91) as *Lophosepion lefebrei*. According to this description the arm-suckers are biserial and the tentacular club bears only three small suckers. Actually this specimen is in such a poor state of preservation that it is impossible to verify Rochebrune's description.

The animal described by Issel (1869, p. 238) as being "*Sepia gibbosa*" probably does not belong to this species but to *Sepia dollfusi* Adam, 1941 (see Adam, 1959, p. 142).

The earlier-mentioned specimens from Eylath, which were entrusted to Adam by Dr H. Steinitz (Hebrew University, Jerusalem) are the first animals known with certainty to belong to *S. gibba*.[1]

The mantle is broadly conical in shape, widest at the opening; in the larger specimens it is more or less cylindrical in its anterior half and bluntly acuminate behind. In the youngest specimens the dorsal margin is slightly convex, becoming more and more angular and projecting in the larger specimens. The ventral margin is very slightly emarginate. The head is short and broad and the eyes large.

All the arms are more or less laterally compressed and keeled on their outer sides, the dorsal ones of the smallest specimens only in their distal halves.

The surface of mantle, head and arms is generally smooth but sometimes has small tubercles. In some specimens the head shows some very distinct, parallel, longitudinal, linear ridges of a light-greyish colour, contrasting with the dark brown or bluish-brown dorsal surface. Two pairs of these ridges are continuous with the outer keels of the dorsal and dorso-lateral arms; the third pair, situated at the margin of the dorsal eye-lid is directed towards the dorsal surface of ventro-lateral arms.

The fins are well developed, beginning nearly at the mantle-margin and extending slightly beyond it; at the posterior end of the mantle they come close together, their free margins extending beyond the end of the body.

In most specimens the arms are sub-equal in length, the ventral ones being generally slightly longer, but in the very young specimens the dorsal arms are distinctly longer. In these small specimens the suckers are biserial at the tips of the arms, especially on the dorsal ones, where they are biserial on approximately the distal halves. This latter character disappears with age and the larger animals have a quadriserial arrangement, except at the extreme tips. The protective membranes are well developed.

The largest male has rather globular suckers with relatively small openings; this is particularly pronounced in the distal suckers. The chitinous rings of the arm-suckers of this male are smooth in the smaller suckers, and irregularly incised at the distal end in the proximal ones.

The left ventral arm is hectocotylized but only slightly transformed; at the base there are seven transverse rows of four suckers, followed by seven or eight transformed rows, the two ventral suckers of each row being only slightly smaller than the normal suckers, but the two dorsal ones are very minute. This transformed portion is not specially enlarged and the suckers remain close together.

The arm-suckers of the female are flatter and not globular, with a wider opening; their chitinous rings are armed all-around with numerous, close-set, bluntly-pointed teeth.

The tentacles are long and slender, the stem is rounded on the outer side, flat on the inner one, with two membraneous ridges which are continuous with the protective membranes of the club. The latter is elongate crescent-shaped. The numerous suckers are arranged in oblique transverse rows of eight. In each row the suckers increase regularly in size up to the fourth (beginning on the

[1] Since this memoir was set up in type, the senior author received a small female of *Sepia gibba* for identification from Professor Dietrich B. E. Magnus (Darmstadt) who collected it in the harbour of Suakin (Sudan). Professor Magnus stated (*in litt.*) that he often observed this species during his nocturnal diving experiments. During the night this *Sepia* lives in a partnership with *Diadema setosa* (Leske) and seeks its prey under the protection of the big spines of these sea urchins.

dorsal side) and then diminish, the fifth sucker having the same size as the second, the sixth the same as the first, the seventh and eighth being slightly smaller; those of the third and fourth longitudinal series are widest. The chitinous rings of the tentacular suckers shows the same dentition as the arm-suckers of the female. The swimming-membrane is well developed and is as long as the club; the protective membranes are well developed but do not extend much beyond the marginal suckers, the dorsal one is largely separated from the stem by a slit between this membrane and the swimming-membrane, but it is connected with the stem by the bases of the suckers as a series of pillars with open spaces between each other.

The web is very low and barely developed. The ventral part of the buccal membrane of the female is only slightly expanded, but this may be due to the young age of the females we examined.

The shell has in all specimens the peculiar shape of this species. It is elongate oval in general outline, without any trace of a spine (pl. 25, figs. 159–161). In very young animals it is broadly rounded at the anterior end and bluntly acuminate at the posterior one; but in older specimens it becomes more and more angular at the anterior end. Its dorsal surface is nearly flat in the greater part of its length, with a faint indication of a median rib; near the posterior end the surface is more angular with flat, sloping sides. The whole dorsal surface is finely granulous, except the narrow chitinous margins, the granules being arranged along the growth lines.

The ventral surface of the youngest specimens is already characterized by the peculiar shape of the striated area. The posterior portion of the latter shows at the end a nearly circular, flat patch, followed by about four widely spaced striae, which are slightly concave in their broad middle part, but have rounded angles in their marginal portions. This whole surface is nearly flat and finely granular; it strongly resembles the striated area of *Hemisepius* (see p. 118). Following this flat posterior part the centre of the striated area is abruptly raised, being first triangular with a rounded rib which widens more and more towards the last loculus. The latter forms a very high rounded protuberance, on both sides of which the striae are strongly convex, so that the length of the lateral parts of the striated area is much longer than in the median line (the latter is given in the table of measurements).

In the anterior part, the lateral portions of the striated area, which are each as wide as the central elevated part, are flat. The last loculus is slightly convex or flat in its anterior and lateral parts, but the centre is raised and forms a rounded conical protuberance; the striae of the striated area do not reach the top of this protuberance.

In lateral view this thick median part is triangular in outline, with a nearly flat anterior side which is slightly concave towards the anterior end, whereas the posterior side is first concave and then flat.

The inner cone is well developed; its limbs are completely fused to the outer cone, but form a rounded marginal rim which is slightly raised in the rounded posterior part. The outer cone completely surrounds the inner cone, it is widest in its lateral parts. In the larger specimens the striated area is separated from the outer cone by a narrow smooth zone, the limbs of the inner cone limiting the striated area.

With the growth of the shell the central protuberance becomes relatively more and more important and swollen, so that it is much narrower at its base and nearly circular in outline in transverse section.

Remarks: This peculiar species is very closely related to *S. dollfusi* (p. 98), the animals scarcely differing, except in the hectocotylus which seems more developed in the latter. The shells, although related, show marked differences in their proportions and in the development of the ventral surface, the protuberance being triangular in cross-section in *S. dollfusi*.

49. *Sepia elobyana* Adam, 1941
(pl. 25, figs. 162–164)

Sepia elobyana Adam, 1941, p. 121, fig. 12; pl. III, fig. 5; 1951, p. 773; 1952, p. 33, fig. 11; pl. I, fig. 5; 1960*a*, p. 469.

TYPE LOCALITY: Eloby Island, Gulf of Guinea.
GEOGRAPHICAL DISTRIBUTION: Gulf of Guinea; Senegal.

DESCRIPTION: This species is only known from the six specimens described by Adam that is, 1 ♂ (holotype) from the Gulf of Guinea and 4 ♂ and 1 ♀ from Senegal. It is a very small species, the largest male specimen measuring only 53 mm in dorsal mantle-length. The mantle is less than twice as long as broad, the dorsal margin projects slightly forward in a rounded angle and the ventral margin is deeply emarginate around the siphon. In well preserved specimens the dorsal surface of mantle, head and arms shows scattered tubercles and a peculiar reticulate system of ridges that are less visible in the female. The fins are broad.

The sub-equal arms measure about half the mantle-length, and are all keeled on their outer sides. Their suckers show a very characteristic structure and arrangement. The dorsal and dorso-lateral arms of the male are effilated at their tips, each bears about 20 transverse rows of rather globular suckers with relatively small chitinous rings which are smooth in the median suckers but are armed each with about 10 sharp, distal teeth in the lateral ones. In the first 12 rows the median suckers are much bigger than the lateral ones. Towards the distal end this difference disappears, the lateral suckers become even more important than the median ones, and on the last few millimetres of the effilated tip only the lateral suckers persist in a biserial arrangement, hidden by the wide protective membranes. The ventro-lateral arms of the male show the same arrangement of the suckers, but the median ones are only slightly larger than the lateral ones and all the suckers have their chitinous rings each armed with 10 to 15 sharp, distal teeth. The ventral arms have wide swimming-membranes and broad protective membranes. The left ventral arm is normally hectocotylized in its proximal half with about seven transverse rows of minute suckers of which two longitudinal series are close together at the ventral side, a third row is in the middle of the arm and the last one near the dorsal side at the base of the protective membrane. In fact, these suckers are arranged in alternate pairs situated on fleshy ridges. The distal part of the hectocotylus bears about 20 rows of normal suckers, the median ones being larger than the lateral ones; all these suckers are each armed with about ten sharp distal teeth. The right ventral arm shows another very peculiar transformation. The distal part of this arm does not differ from that of the left arm. At the base of the arm there are two transverse rows of normal suckers, followed by four rows of transformed suckers, the lateral ones of which are slightly smaller than the other lateral suckers. The median suckers of these four rows (and in the largest male also the lateral ones) have their chitinous rings without teeth; these rings are very wide and thick, especially on the proximal side where they are expanded and curved. In these suckers the chitinous ring covers the whole diameter of the fleshy part in which there is no trace of the papillate zone which surrounds the chitinous ring in normal suckers.

In the female, the dorsal and dorso-lateral arms are effilated at their tips and carry minute, biserial, distal suckers; on the ventro-lateral arms the suckers are quadriserial throughout. All the suckers are each armed with about ten distal teeth, which are much smaller than in the male, and they have very tiny teeth on the proximal part of their chitinous rings.

The tentacular club measures about 30% of the mantle-length and is rather slender. In the type specimen the tentacular suckers are very unequal on the middle part of the club where they probably form oblique transverse rows of eight. The first sucker of these rows is small, the second about twice as wide and the third one is very large, being about twice as wide as the second.

These large suckers are even larger than the biggest arm-suckers. In all the other specimens the tentacular suckers are sub-equal, arranged in oblique transverse rows of eight. These suckers have their chitinous rings each armed with about eight to ten rather long, spaced, distal teeth and with about the same number of much smaller, more widely spaced, proximal teeth.

The shell has no spine, only a very weak, blunt protuberance. It is rather acuminated at the anterior end and is broadly rounded at the posterior one (pl. 25, figs. 162–164). The dorsal surface is regularly curved, without any ribs, very finely, more or less reticulate granulous. It is very flat, the last loculus hardly attaining the level of the chitinous margin. The ventral surface shows a broad, shallow groove in the striated area and a narrow furrow on the last loculus. As the wide groove shows some other faint grooves, the striae are wavy, but their general outline is convex. The striated area is separated from the outer cone by broad, smooth, marginal zones. The inner cone is completely fused to the outer cone, its posterior part surrounding a faint depression; the lateral limbs are rather wide, their bases being situated at the margins of the striated area. The outer cone is broad in its lateral parts and continuous behind the inner cone. The shell of the type is much narrower (37·5%) than the shells of the other specimens examined (♂: 44%; ♀: 46%) but does not differ in any other respect.

Remarks: This very characteristic species does not seem to be related to any other species known. We hesitated very much before considering the specimens from Eloby Island and those from Senegal as belonging to the same species, because of the completely different tentacular suckers. The relative size of the club-suckers may vary in a slight degree in a same species, as we mentioned for *S. prashadi*, but in no other species did we find such an important difference in the tentacular clubs. In the type-specimen only the left tentacle was preserved and unfortunately no other specimens are known from the type locality. The difference in the relative width of the shell may have a sub-specific importance, but if the differences in the tentacular clubs turn out to be constant characters we shall have to reconsider how to interpret the case of these two forms, which both have the very peculiar arrangement and structure of the arm-suckers, that we have never seen in any other species.

50. ***Sepia bandensis*** Adam, 1939
(Pl. 26, figs. 165–168; pl. 44, fig. 266)

Sepia bandensis Adam, 1939, p. 1, figs. 1–4; 1939*c*, p. 53, pl. III, figs. 4 & 5.

Type locality: Banda Neira.

Geographical distribution: Banda Neira; Ambon; Java; Pulu Sanguisiapo, Tawi-Tawi Islands (Sulu Archipelago); Smaller Sunda Islands; Sanoer (South coast of Bali; shell only).

Description: The following description is based on the original material from Banda Neira. The largest male specimen has a mantle-length of 58 mm and the largest female a mantle-length of 48 mm.

The mantle is broadly rounded at its dorsal anterior margin and the ventral margin is slightly concave. The mantle width varies between 51% and 70% of the length.

The head is short and broad and the arms short, not exceeding half the mantle-length. All the arms are keeled on their outer sides and possess narrow protective membranes. The web measures up to 23% of the longest arm.

The suckers are quadriserial, their chitinous rings are each armed with about 15 long distal denticles, which are more or less fused in the male, whereas in the female the rings are armed all round with a larger number of partially fused denticles.

The left ventral arm of the male is hectocotylized. The suckers of the fifth up to the eleventh transverse rows, especially the ventral ones, are much smaller than the ordinary suckers.

The tentacular club is short, being about one fifth of the mantle-length in size. Its oval sucker-bearing surface is distinctly detached from the stem and formed mainly by the wide ventral protective membrane and by the well-developed dorsal membrane; the latter is separated from the swimming-membrane by a deep groove which reaches up to the level of the muscular bases of the median suckers. The two dorsal rows of suckers are situated on the free portion of the membrane (pl. 44, fig. 266). The well-developed swimming-membrane is somewhat longer than the club. There are five longitudinal rows of suckers, those of the median row being wider than the other ones. The protective membranes of the tentacular club are fused at its base.

The shell is broadly oval, regularly rounded at its anterior margin and slightly acuminate behind, being about twice as long as wide; it is wider in the female than in the male (pl. 26, figs. 165–168). Its dorsal surface is regularly convex, without any ribs, and it is strongly calcified with a reticulate pattern of granules.

The ventral surface is flattened and is concave in the middle, this latter character being more distinct in the female than in the male. The striated area is very long with a very faint median groove, which is barely visible. The striae are regularly rounded. The inner cone has its lateral limbs nearly completely fused with the outer cone. There is only a slightly-raised posterior rim which surrounds the posterior depression. The rather broad outer cone is continuous behind the inner cone. There is a blunt posterior knob, but no spine. The chitinous margin of the whole shell is very narrow.

Remarks: This species is not represented in the collections of the British Museum. As Adam (1939*c*, p. 55) pointed out, its shell closely resembles that of *Sepia tuberculata*, the only noteworthy difference being the absence of the posterior knob in the latter species. In this respect the shell of *Sepia bandensis* is related to that of *Sepia papillata* which has a more developed posterior knob, a dorsal rib, a distinct ventral median groove which gives an angular form to the striae, and narrower limbs in the inner cone. But the animals of *Sepia tuberculata* and of *Sepia papillata* are completely different.

On the other hand the tentacular club of *Sepia bandensis* is of the same type as in *Sepia apama* and *Sepia latimanus*. Without examination of the shell, *Sepia bandensis* could be mistaken for a young *Sepia latimanus*, or *S. apama*, but its shell has not the slightest relation to that of these two species.

The differences between the shell of *Sepia baudeusis* and those of *Blaudosepia baxteri* and *Blandosepia bartletti* are discussed under these species (p. 106).

There is no point in discussing the relationship between species having similar shells, as long as the animals are unknown.

51. ***Sepia baxteri*** (Iredale, 1940)

Blandosepia baxteri Iredale, 1940, p. 442; 1954, p. 67, pl. V, figs. 12–14.

Type locality: Lord Howe Island.

Remarks: The author made this new species the type of a new genus without giving diagnoses, either of the species or of the genus. He states only that the shell very closely resembles that of *Solitosepia mestus* save for the lack of the spine. The type measures 74 × 32 mm and the largest shell 90 × 37 mm. According to his opinion "it is possible that the genus may include the *mestus*-spined series, which disagrees from typical *Solitosepia* in many features".

As we state under *Sepia mestus* Gray, the shell described by Iredale (1926, p. 189, pl. XXI, figs. 4 & 5) as being this species is different from the type specimens, whereas *Solitosepia liliaua* Iredale (1926, p. 189 pl. XXI, figs. 1–3) does not seem to differ at all from the types of *Sepia mestus* Gray. In our opinion, *Solitosepia liliana* is a synonym of *Sepia mestus*, which species becomes the type of *Solitosepia*. So, if "*mestus*" ought to be transferred to *Blandosepia*, as Iredale suggests, this latter genus becomes a synonym of *Solitosepia*.

On the other hand, as we pointed out on page 47, *Sepia verreauxi* Rochebrune, the type-species of *Ascarosepion* Rochebrune, is identical with *Sepia mestus* Gray, so that *Solitosepia* is merely a synonym of *Ascarosepion*.

Unfortunately, Iredale does not compare his *Blandosepia baxteri* with other species. In a later paper, Iredale (1954, p. 67, pl. V, figs. 12–14) has figured his species and given some more information on the sizes of some additional shells, *viz*:- 28 × 13, 44 × 21, 59 × 25, 75 × 34, 77 × 32, 83 × 37 mm.

He gives the following description:—

> "The bone is elongately oval, the dorsal area finely granulose, showing faintly a dorsal rib and adjacent lines, scarcely separating areas. This is brownish pink and the outer cone which is produced is whitish, weakly calcified, and bounded by a narrow, horny margin which extends round the bone. There is no spine, but only a slight knob. The inner cone is well developed as a narrow band, reaching in front of the siphonal cavity, and enclosing a striate area. The striated area is long, and while it does not show any ventral sulcus, there is a shallow median depression with minor ridges each side. The last loculus shows a faint linear median depression and the usual marginal lines. It resembles in most features, as noted above, *Solitosepia mestus*, but as well as the lack of the spine, the dorsal surface shows more definite traces of sculpture than is met with in *mestus*."

In our opinion Iredale's species is very closely related to *Sepia bandensis* Adam, 1939, but the shell of the former is slightly acuminate in front, whereas the latter is evenly rounded. Judging from the original figures it even more closely resembles that of *Sepia papillata*.

The general outline of the shell of *Sepia bandensis* resembles still more that of *Blandosepia bartletti* Iredale, 1954 (p. 67, pl. V, figs. 15 & 16) from Misima and the Conflict group (Louisiade Archipelago).

According to Iredale this is a "shell recalling *Solitosepia liliana* of New South Wales, but lacking any spine". As we mentioned above, Iredale's *Solitosepia liliana* is in fact *Sepia mestus* Gray. The figured type of *Blandosepia bartletti* measures 73 × 37 mm, other specimens: 45 × 20, 45 × 24, 50 × 29, 62 × 29, 68 × 33 and 70 × 34 mm. It resembles *Blandosepia baxteri*, but no dorsal sculpture is visible. "The ventral surface has the inner cone similar, but smaller, and the long striated area shows no signs of sulcus or groove, and is more excavate throughout. The last loculus shows a shallow depression medially, and is never more elevate than the margin."

The author mentions *Sepia bandensis* Adam as a similar bone, which "seems referable to a different source of evolution". In fact, the outline of the striae is quite different, otherwise we do not see any difference. As to the question whether *Sepia bandensis* is of a different origin there is no point in discussing it as long as the animal of *Blandosepia bartletti* is unknown.

52. ***Sepia tuberculata*** Lamarck, 1798

(Pl. 26, figs. 169 and 170; pl. 27, figs. 171 and 172; pl. 28, figs. 173 and 174; pl. 44, figs. 265 and 268)

Sepia tuberculata Lamarck, 1798, p. 130; 1799, p. 9, pl. I, figs. 1^{A-B}; Férussac & d'Orbigny, 1835–1848, p. 277, pl. 6 (*nec* pl. 3ter, 17, figs. 13–15); ? Steenstrup, 1875, p. IV, pl. I, figs. 20 & 21; pl. II, fig. 6; Adam, 1941, p. 113, pl. III, fig. 8.
Spathidosepion tuberculatum, Rochebrune, 1884, p. 93, pl. IV, fig. 3; Adam, 1944, p. 226.
Hemisepius (?) *tuberculatus*, Smith, 1916, p. 25.
? *Sepia mamillata* (Leach ms.) Férussac & d'Orbigny, 1835–1848, p. 277, pl. IVbis.

TYPE LOCALITY: ?
GEOGRAPHICAL DISTRIBUTION: South Africa.
MATERIAL:

a. ? (Purchased Damon); B.M. 1868.6.8.1; 1 ♂.
b. St. James, South Africa (Pres. Prof. Stephenson), 11.ii.1933(F.127); B.M. 1935.3.12.4; 1 ♀.

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a	♂	47	92	66	60	53	96	15+	57
b	♀	64	92	70	47	55	102	19	53

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	♂	47	60	57	57	106	23·5	2·1	3·2
b	♀	64	52	52	59	117	31	2·3	3·9

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.
b	♀	60	45	6·7[1]	55

DESCRIPTION: The female specimen from St. James is well represented on pl. 27, figs. 171 & 172. The ventral side of the mantle shows the characteristic lateral pads with their wrinkled surface; similar pads are present on the ventral surface of the ventral arms[2]. The dorsal and lateral arms have their tips drawn out and are armed with minute suckers. These tips are longest in the dorsal arms, they are shorter in the dorso-lateral and shortest in the ventro-lateral ones. The ventral arms are normal and have much larger suckers at their distal end. The suckers of all the arms are quadriserial. The protective membranes are wide, covering the suckers of the effilated arm-tips.

The tentacular club has a well-developed swimming-membrane, about one and a half times as long as the club; the protective membranes are fused at the base of the club, forming a single membrane which is connected with the end of the swimming-membrane (pl. 44, figs. 265 & 268). The suckers give the appearance of being arranged in five or six longitudinal series, three suckers of the third row being much larger than the other ones; in fact the suckers are arranged in very oblique transverse series of eight.

The flattened inner surface of the tentacular stem has two membraneous ridges, joining the protective membranes.

The male specimen has its left ventral arm hectocotylized: a little more than the basal half is transformed, with two series of nine small suckers on both sides, separated by a broad transversely ridged area; the distal part of this arm is normal, bearing about 15 transverse rows of suckers.

The shell of the female specimen is very flat; the ventral surface has a narrow median groove over its whole length as well as some other radiating grooves separated by low ribs, giving a wavy appearance to the striated zone; the general outline of the striae is convex. The limbs of the inner cone are narrow, raised as low rounded ridges on their whole length and largest at the posterior end (±1·5 mm). The dorsal surface is regularly rounded without ribs.

At the posterior end there is neither spine nor knob. This shell is a little more acuminate than the one figured by Adam (1941, pl. III, fig. 8).[3]

[1] The thickness is measured in the median part of the shell, the lateral margins being higher.

[2] Professor J. H. Day kindly informed us that according to his personal observations, these curious formations function as suckers with which the animals, living in the tidal zone, adhere temporarily to the rocks, preventing them from being swept away by the waves.

[3] In the explanation of this figure Adam indicated this shell as "*Sepia tuberculata* Quoy & Gaimard" from Cape of Good Hope, but in his text (p. 116) pointed out that the specimen from the Museum of Natural History in Paris bears an erroneous indication.

REMARKS: As Adam (1941, p. 116) indicated, this species has been erroneously synonymized with *S. papillata* by Férussac & d'Orbigny (1848, p. 277). Rochebrune (1884, p. 93–95) was perfectly right in separating them.

The specimen which Steenstrup (1875, p. IV) mentioned as probably belonging to *S. tuberculata* differs from this species in having the arm-tips armed with eight instead of four series of suckers. According to Hoyle (1910, p. 267) it was clear from d'Orbigny's identification that *S. papillata* is a synonym of *S. tuberculata*, but we have not the slightest doubt that the specimens which Hoyle described as being *S. tuberculata* belong in fact to *S. papillata*.

Smith (1916, p. 26) separated both species again and stated: "but it seems to me doubtful whether they even belong to the same genus, and it is possible that *S. tuberculata* may even be identical with the preceding species" (*Hemisepius typicus*). This latter hypothesis certainly cannot be maintained. Moreover, the shell figured by Smith (1916, pl. II, figs. 1 & 2) as belonging to *S. papillata*, belongs in fact to *S. simoniana*.

The animals of *S. tuberculata* and *S. papillata* are very much alike but the tentacular club differs in the enormous size of the median suckers in the latter species. The shell of *S. tuberculata* is flatter, its dorsal surface is devoid of a median rib, the striae of the ventral surface are rounded, the limbs of the inner cone are wider and the spine or posterior knob is lacking.

The shell of *S. tuberculata* most closely resembles that of *S. bandensis* (p. 105); the only difference being a slight indication of a posterior knob in the latter; however, the animals, especially as regards their tentacular clubs, are quite different.

53. ***Sepia papillata*** Quoy & Gaimard, 1832
(Pl. 28, figs. 175–178)

Sepia papillata Quoy & Gaimard, 1832, p. 61, pl. I, figs. 6–14; Férussac & d'Orbigny, 1848, pl. 3ter, pl. 17, figs. 13–15; Tomlin, 1923, p. 40; Massy, 1925, p. 211; 1928, p. 92; Turton, 1932, p. 1; Adam, 1939*c*, p. 55, pl. III, fig. 6; 1941, p. 112; Voss, 1962*b*, p. 251.
Spathidosepion papillatum, Rochebrune, 1884, p. 94; Adam, 1944, p. 226.
Sepia tuberculata, Hoyle, 1910, p. 265, pl. IV^{a}, figs. 4–6 (*non* Lamarck).

TYPE LOCALITY: Cape of Good Hope.
GEOGRAPHICAL DISTRIBUTION: South Africa.
MATERIAL:
a. Port Elizabeth (Spencer); B.M. 1890.12.14.45; 1 shell.
MEASUREMENTS:

		SHELL (IN % OF SHELL-LENGTH)			
Loc.	L. in mm	W.	Th.	Str.z.	Observations
	108	43·5	10	±66	pl. 28, figs. 175 & 176

DESCRIPTION: Among the many shells labelled *Sepia papillata* in the collections of the British Museum, only the above belongs to this species; the others we have referred to *S. simoniana* (see p. 109).

The shell is broadly oval; its dorsal surface has a broad median rib and two shallow grooves and is reticulate granulous, especially near the posterior end. The latter has a blunt knob under which the thickened, calcareous, lateral parts come together, separated by the chitinous posterior margin of the outer cone (pl. 28, figs. 175–178). The ventral surface has a deep median groove, on both sides of which the shell is convex; the striae have a reversed V-shaped outline. On both sides of the striated area there is a narrow smooth area. The inner cone has narrow limbs, widening only slightly in the posterior part which is fused with the outer cone, its outer half being thicker and flat, surrounding the posterior excavation. The broad outer cone completely surrounds the inner cone.

Remarks: The shell figured by Smith (1916, pl. II, figs. 1 & 2) as *S. papillata* differs in the very broad inner cone and belongs to *S. simoniana* (see below).

As Adam (1941, p. 115) stated, the type of *S. papillata* was collected at Cape of Good Hope and not at Port Dorey as erroneously given by Rochebrune (1884, p. 95).

The animal of *S. papillata* strongly resembles that of *S. tuberculata* in the oval pads on the ventral surface of the mantle (see p. 107), and also in the tentacular club which differs in the presence of two or three enormous median suckers, attaining diameters of 10 mm and covering the whole width of the club.

According to Massy (1925, p. 212) the left ventral arm is hectocotylized. At the base are four rows of two to three normal suckers, followed by "15 rows of diminutive suckers placed 2 in a row, in zigzag order, with shallow grooves between them. The distal third of arm is normal".

The shell of *S. papillata* differs in the presence of a dorsal rib, in having a distinct posterior knob, in the angular outline of the striae and in the narrower limbs of the inner cone. It is very similar to that of *S. simoniana* (see p. 111), the latter differing in the drawn-out posterior portion of the inner cone.

The tentacular club of *S. simoniana* is completely different (pl. 42, fig. 254).

54. ***Sepia simoniana*** Thiele, 1921
(Pl. 29, figs. 179–182; pl. 42, fig. 254)

Sepia simoniana Thiele, 1921, p. 436, pl. LII, figs. 5–13; Odhner, 1923, p. 7; Voss, 1962*b*, p. 250.
Sepia natalensis Massy, 1925, p. 212, pl. XI, figs. 1–11; pl. XIV, fig. 37.
Sepia tuberculata Gray, 1849, pp. 101, 102 (*non* Lamarck, 1799).
Sepia papillata Smith, 1916, p. 22, pl. II, figs. 1 & 2 (*non* Quoy & Gaimard).

Type localities: Simon's Bay (*S. simoniana*); Cape Henderson, Durban (*S. natalensis*).
Geographical distribution: South Africa.[1]

Material:

a. Cape of Good Hope (det. Gray as *S. tuberculata*); 1 shell (imperfect; width 65 mm, with deep ventral groove and wide inner cone); B.M. 196397W.
b. S. Africa (Ponsonby); B.M. 1890.5.20.54; 1 shell (ventral groove rather shallow).
c. Port Elizabeth (Ponsonby); B.M. 1890.9.22.229–231; 3 shells.
d. Port Elizabeth (Spencer); B.M. 1890.12.14.39–41; 3 shells (one of these is doubtful).
e. 18 miles E. of Cape Agulhas, 35 fms., muddy bottom, 21.vii.1948 (Univ. Cape Town, Ecol. Surv., TRA 27 C); 5 ♀♀. B.M. 196398W.
f. Grahamstown, Natal; B.M. 1952.ii.24.3–4; 2 shells.
g. Isipingo (Falcon); B.M. 1952.12.30.73; 1 shell.

Measurements:

Animals (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
e	♀	180	83	53	42	41	94	11	47
	♀	165	90	58	51	39	97	—	—
	♀	162	87	59	44	41	99	12	40
	♀	140	84	56	49	41	±93	±8·5	39

[1] According to Barnard (*in litt.*) the S. African Museum has a ♀ specimen taken off the Tugela River, Natal, in 63–73 fms.

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
e	♀	180	44	50	47	122	49	1·8	0·55
	♀	165	—	—	—	—	—	—	—
	♀	162	40	43	43	99	56	2·15	0·6
	♀	140	43	46	43	—	—	2·15	—

SHELLS (IN % OF SHELL-LENGTH)

Loc.	L. in mm	W.	Th.	Str.z.	Observations
d	137	44	11·5	±59	
b	131	38	9	±64	
g	121	43	10	±65	
f	120	45	12·5	±71	
f	114	49	12·5	±70	
c	112	44	10	±62	
d	111	48	14·5	—	pl. 29, figs. 181 & 182
d	107	47	12	±70	
c	105	41	11	±62	
c	90	43	13	63	

DESCRIPTION: The female specimens (*e*) have the dorsal mantle-margin bluntly angular in shape anteriorly. The fins extend beyond the mantle-margin and come close together at the posterior end.

The web attains about half the arm-length and is sub-equal between the dorsal, dorso-lateral, ventro-lateral and ventral arms, it is absent between the ventral arms. The big globular arm-suckers are quadriserial with smooth chitinous rings.

The tentacular club is very long; the swimming-membrane has the same length as the club and the protective membranes extend slightly on the stem beyond the sucker-bearing surface (pl. 42, fig. 254).

The sub-equal tentacular suckers are arranged in about 24 longitudinal series; their chitinous rings are armed with about 20-25 teeth, the distal ones are spaced, being long and sharp.

One of these specimens shows about six long tubercles at the base of the fins.

All the shells, except the one measuring 111 mm (*d*), agree perfectly with the original descriptions. Their general shape is broadly oval being rounded at both ends. The dorsal surface has a wide, low, median rib, limited by two narrow grooves. Nearly the whole surface is reticulate calcareous, except the rather wide chitinous margins. There is a blunt knob at the posterior end where the thick, lateral, calcareous zones come together.

The ventral surface is generally rather thick, with a more or less developed median groove over its whole length. On both sides of this groove the striated zone is more or less convex with an irregular number of very faint radiating grooves, which cause the striae to be slightly wavy; the general outline of the striae is reversed V-shaped, especially in the anterior portion. On both sides of the striated area there is generally a more or less narrow smooth zone.

The inner cone is very large and completely fused to the outer cone; its posterior portion is drawn out and nearly reaches the posterior margin of the large outer cone.

The dubious specimen (*d*), measuring 111 mm in length, differs from all the other ones by its greater thickness, in the barely indicated median groove and in the less developed inner cone (pl. 29, figs. 181 & 182).

The left ventral arm of the male, as described by Thiele (1921, p. 438) is hectocotylized in its proximal half, the second longitudinal series of suckers almost lacking, both the ventral series being smaller than the normal suckers.

Remarks: The only noteworthy difference between the shells of *Sepia papillata* and *S. simoniana* is the enormous development of the inner cone in the latter. The animals differ principally in the completely different tentacular club.

55. *Sepia* sp.
(Pl. 30, figs. 183 & 184; pl. 46, fig. 276)

Material:

a. John Murray Exp. Sta. 27, 11°57′12″N., 50°35′00″E. to 11°56′42″N., 50°39′12″E., near Cape Guardafui, 37 m, 12.x.1933; 1 young specimen. B.M. 196399W.

b. John Murray Exp. Sta. 106, 5°38′54″S., 39°15′42″E. to 5°40′18″S., 39°17′36″E., Zanzibar area, 212 m, 12.i.1934; 1 young specimen. B.M. 1963100W.

Measurements:

Animal (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a	—	23·5	98	64	34	51	—	—	30

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	—	23·5	26	28	30	98	15	—	—

Shells (in % of shell-length)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Observations
a	—	23	54	8·7	61	pl. 30, figs. 183 & 184
b	—	19	58	—	63	

Description: The mantle is broadly oval, with the dorsal margin slightly convex and the ventral one distinctly emarginate. The head shows a few big cirri above each eye. The arms are short, laterally compressed and keeled on the outer sides. The web is high between the dorsal, dorso-lateral and ventro-lateral arms, reaching about two-fifths of the arm length; it is less developed between the ventro-lateral and ventral arms and non-existent between the ventral ones. The suckers are quadriserial.

The tentacular club has a well-developed swimming-membrane exceeding the length of the club for about half its length (pl. 46, fig. 276). The dorsal protective membrane is wide at the base. The minute suckers are numerous and are arranged in at least 12 longitudinal series.

The shell is broadly oval, rounded at both ends, with a very faint indication of a flat median rib on its dorsal surface; the whole surface being slightly reticulate granulous (pl. 30, figs. 183 & 184). The ventral surface is very flat with a faint, narrow, median groove. The striae of the striated area are slightly convex, flanked by two broad, smooth, marginal zones. The inner cone has narrow, slightly raised, limbs, situated approximately in the middle of each smooth zone; the posterior part forms a narrow, rounded ridge, surrounded by the narrow posterior part of the broad outer cone. The spine is very short; it is damaged.

Remarks: These specimens seem to be closely related to *Sepia simoniana* (= *S. natalensis*), but as we have never seen young specimens of the latter, it would be hazardous to consider them conspecific until more material is known. There are small differences—the tentacular club seems to be less elongate, the shell flatter, the inner cone less developed, but these may be juvenile characters.

56. *Sepia myrsus* Gray, 1849
(Pl. 30, figs. 185 & 186)

Sepia myrsus Gray, 1849, p. 108.

TYPE LOCALITY: China (?).
GEOGRAPHICAL DISTRIBUTION: ?
MATERIAL:

a. China?; B.M. 1841.4.6.89; 1 shell (holotype).

MEASUREMENTS:

SHELL (IN % OF SHELL-LENGTH)

Loc.	L. in mm	W.	Th.	Str.z.	Observations
a	72	44	11·8	58	pl. 30, figs. 185 & 186

DESCRIPTION: This shell has clearly suffered a deformation during its growth. Otherwise we cannot find any difference between this species and *Sepia simoniana*, but as the animal of the former is unknown and if the locality "China" is exact, it is impossible to take a decision about regarding these two species as identical.

57. *Sepia hieronis* (Robson, 1924)
(Pl. 30, figs. 187 & 188; pl. 43, fig. 262)

Sepia sp.A. Robson, 1924, p. 13.
Rhombosepion hieronis Robson, 1924*a*, p. 645, pl. II, figs. 9–11; Massy, 1927, p. 158.
Sepia hieronis, Voss, 1962*b*, p. 251.

TYPE LOCALITIES: Cape Town, S. Africa: Sta. 8 (126 fms.), Sta. 7 (112 fms.), Sta. 33 (150 fms.), Sta. 2 (117 fms.), (according to Barnard, *in litt.*, these localities are in the Saldanha Bay–St. Helena Bay area and not off Cape Town).
GEOGRAPHICAL DISTRIBUTION: South Africa.
MATERIAL:

a. Cape Town, Sta. 7, 112 fms.; B.M. 1924.9.9.54–5: syntypes; 1 ♂ (without shell), 1 ♀ (with shell), 1 shell (probably from Sta. 2) (Robson, p. 645, mentions 2 ♀♀ for Sta. 7) (according to Barnard, *in litt.*, the exact locality is in the Saldanha Bay–St. Helena Bay area: 32°32′S., 17°42′E.).
b. Cape Town, Sta. 2, 117 fms.; B.M. 1924.9.9.56: syntypes; 1 ♀ (distorted), 1 shell (according to Barnard, *in litt.*, the exact locality is in the Saldanha Bay–St. Helena Bay area: 33°3′S., 17°42′E.).
?*c*. Natal; B.M. 1924.9.9.72–3; 1 shell. (det. Robson as "*S. acuminata*, juv. No. 109; see p. 53).
d. Lion's Head S.E.7 S, 50 miles, shrimp trawl, 230 fms., gn.s. (P.F.15057, No. 1306; det. Massy); B.M. 1926.10.20.5; 1 juv. (M.L.d. = 8 mm).
e. Lion's Head S.E.7 S, 50 miles, shrimp trawl, 230 fms., gn.s. (1261, No. 24; det. Massy); B.M. 1926.10.20.12–13; 2 juv. (M.L.d. = 12 and 19 mm).
f. Univ. Cape Town Ecol. Surv., Afr. 716.H, 9.vi.1947; 1 ♀ (distorted; M.L.d. = 58 mm). B.M. 1963101W.
g. S. African Coast, 30°09′S., 19°02′E., 144 fms., 10.ix.1947, Afr. 761E (Pres. J. H. Day); B.M. 1958. 8.20.7; 1 ♀.

MEASUREMENTS:

ANIMAL (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
g	♀	61	74	54	38	51	85	8	38

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
g	♀	61	38	38	38	—	10	1·64	0·49

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Observations
a	—	60	42	11·7	65	pl. 30, figs. 187 & 188
c	—	56	39	9·8	70	
a	♀	49	44	12·2	59	
b	—	42	48	12·4	57	

DESCRIPTION: Most of the specimens are hardened in alcohol and cannot be measured properly.

The only male specimen (*a*) has the proximal half of all its arms with normal suckers in transverse rows of four, the median suckers being slightly wider than the lateral ones. The dorsal arms have their distal parts normal, the suckers diminishing gradually in size. The dorso-lateral arms have three pairs of enormously enlarged suckers at the base of the distal halves. They attain diameters of 2 mm, whereas the normal suckers are only half as wide. The ventro-lateral arms possess three or four pairs of slightly enlarged suckers at the base of the distal third, the biggest one measuring about 1·6 mm in diameter. The right ventral arm has much smaller suckers on its middle third, followed by five pairs of bigger suckers, measuring up to 0·9 mm. All the arm-suckers have smooth rings. The left ventral arm is hectocotylized, with one normal sucker at its base. The proximal half of this arm is transformed with very small, widely-spaced suckers; the ventral ones are mostly lacking. This transformed portion is transversely striated, without any longitudinal ridge of the kind found in *S. acuminata*. The distal half has biserially arranged suckers, the first six pairs of which are much bigger than the others.

The tentacular club has about five rows of minute suckers but is not well enough preserved to be described in detail.

One female specimen (*g*) is in rather good condition. It has the ventral part of the buccal membrane very strongly developed and reflected towards the ventral side.

The dorsal and dorso-lateral arms show a peculiar transformation. On the dorsal ones all the suckers are arranged in two longitudinal series. On the dorso-lateral ones they are irregularly arranged on the basal part of the arm, due to contraction, but in fact they are biserial; in the middle part there are four pairs of enlarged globular suckers, each attaining a diameter of about 1·4 mm, whereas on the distal third of the arm they become abruptly much smaller and quadriserial. On the ventro-lateral and ventral arms the suckers are also biserial on the basal two-thirds, but due to contraction on fixation this arrangement is obscured and they seem to be placed in three series. The tips of all the arms, except the dorsal ones, seem to have the quadriserial arrangement of the suckers, but we are not sure that this is not due to contraction and that, in fact, all the suckers are biserial.

The tentacular club bears five or six rows of minute suckers (pl. 43, fig. 262). The dorsal protective membrane is very broad without any suckers. The swimming-membrane is well developed and extends down the tentacular stem for a distance nearly half the club-length.

The female syntype (*a*) has no enlarged suckers on its dorso-lateral arms. In the female (*f*) the enlarged suckers are well developed on the lateral arms, especially on the dorso-lateral ones, and even, to a lesser degree, on the ventral arms.

The shell differs only slightly from that of *Sepia acuminata*. Its ventral surface is a little more elevated. The striated zone has a distinct median groove and is limited by two marginal, slightly concave areas; the limbs of the inner cone are situated at the base of the outer cone. There is no terminal spine, only a blunt knob. A broad portion of the outer cone surrounds the inner one (pl. 30, figs. 187 & 188).

REMARKS: In some respects the shell resembles that of *Sepia savignyi*, but the latter shell is less rhomboidal, the marginal areas of the striated zone are completely smooth and much wider, the limbs of the inner cone broader and their free ridge flattened; moreover it has a short spine.

58. ***Sepia insignis*** Smith, 1916
(Pl. 31, figs. 189–191)

Sepia insignis Smith, 1916, p. 25, pl. II, fig. 10; Tomlin, 1923, p. 41.

TYPE LOCALITY: Tongaat Beach, Natal.
GEOGRAPHICAL DISTRIBUTION: Natal.
MATERIAL:

a. Tongaat Beach, Natal (Burnup); B.M. 1920.3.23.5; 1 shell (figured holotype)

MEASUREMENTS:

		Shell (in % of shell-length)			
Loc.	L. in mm	W.	Th.	Str.z.	Observations
a	26	33	16·5	65	pl. 31, figs. 189–191

DESCRIPTION: The shell is acutely angular in its anterior portion and broadly oval in its posterior half. Its dorsal surface is curved along its entire length, bluntly keeled in the middle, pink coloured (especially in the central and posterior part) and very faintly rugose. The ventral surface is flat with a broad, shallow, median groove in the striated zone, lined by two blunt ribs. The striae become more and more angular towards the last loculus, which is faintly convex. The inner cone shows nearly the same width throughout its whole length; its limbs, which extend almost along the entire length of the striated zone, and its posterior portion are narrow and flattened, only the extreme posterior part, which surrounds a very shallow depression, is slightly raised. The outer cone is broad, surrounding the inner cone. There is no indication of a spine.

REMARKS: This species, the animal of which is unknown, does not seem to be related to any other species hitherto described.

59. ***Sepia (Metasepia) pfefferi*** Hoyle, 1885
(Pl. 43, fig. 256)

Sepia (*Metasepia*) *pfefferi* Hoyle, 1885, p. 199; 1885*a*, p. 304; 1886, p. 145, pl. XXI, figs. 1–10; Brazier, 1892, p. 13.
Metasepia pfefferi, Iredale, 1954, p. 78.
? *Metasepia pfefferi laxior* Iredale, 1926*a*, p. 240, pl. XXXV, figs. 9 & 10; 1954, p. 78.
? *Metasepia pfefferi wanda* Iredale, 1954, p. 78, pl. V, figs. 9–11.

TYPE LOCALITY: Challenger Sta. 188, 9°59′S., 139°42′E., South of Papua, Arafura Sea, 28 fms., gn.m.

MATERIAL:

a. Holotype (Challenger Sta. 188), 10.ix.1874; B.M. 1890.1.24.11; 1 ♀.

MEASUREMENTS:

ANIMAL (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a	♀	52	94	—	48	63	96	11·5	38

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	♀	52	52	58	58	115	11·5	2·3	3·3

SHELL (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z
a	♀	42	55	16	71

DESCRIPTION: The mantle is broadly oval, its dorsal margin being slightly angular and the ventral margin a little emarginate. The ventral surface shows a V-shaped ridge, situated at about 12 mm distance from the base of the fins, the surface at the outer side of this ridge being covered with small papillae.

The dorsal arms are distorted, the remaining ones are provided with keel-like swimming-membranes. The suckers are quadriserial, short-stalked and more or less imbedded in the arm-surface. Their chitinous rings are finely toothed in the distal half, each surrounded by a narrow papillate area and a wider, radially grooved, outer area, which is emarginate on the distal side.

The tentacular club is short with its swimming-membrane nearly twice as long (pl. 43, fig. 256). The dorsal protective membrane is separated from the stem by a deep groove; at the base of the club it remains separated from the ventral membrane. The tentacular suckers are very few in number; they seem to be arranged in about five longitudinal series but this is difficult to make out because of the enormous size of three or four median suckers, which are much larger than shown in the original figure.

The shell is rhomboidal, much shorter than the mantle, which extends beyond the posterior end of the shell. It is bluntly acuminate at both ends and more or less angular at the lateral margins. The dorsal surface is completely chitinized and has no median rib; it is faintly convex in the middle, flatter towards the margins and has radiating longitudinal lines.

The ventral surface is rather thick in the anterior third, with a deep median furrow in the anterior part of the striated area, both halves of the latter being strongly convex anteriorly, flatter in their posterior part, and with irregular radiating smaller grooves which give a wavy aspect to the striae whose general outline is reversed V-shaped. The last loculus is very short. The inner cone forms a narrow, rounded ridge, gradually diminishing towards the posterior end. The outer cone is narrow, surrounding the inner cone. There is no posterior depression. According to the original description (Hoyle 1886, p. 146) "a number of radiating calcareous streaks pass outwards into the horny termination" from the rounded angle of the inner cone.

REMARKS: According to Hoyle (1886, p. 147) the fact that the chitinous portion of the shell of *Sepia pfefferi* is visible over the whole of its dorsal surface "separates it clearly from all *Sepiae* or related forms, with two exceptions, *Sepia tuberculata* Lamarck, and *Hemisepius typicus* Steenstrup". In fact, the latter species has a chitinous dorsal surface, but in the former it is normally calcified; probably Hoyle has seen a decalcified specimen.

Iredale (1926*a* p. 240, pl. XXXV, figs. 9 & 10) described a new sub-species *laxior*, based on three shells from Masthead, which differ from the type in being relatively broader, measuring: 51 × 32 (W. = 63%), 36 × 24 (W. = 67%) and 27 × 16 (W. = 59%). According to Iredale "in the largest specimen there is a calcification, unfortunately broken, which suggests a spine formation".

In a later publication Iredale (1954, p. 78) mentions this sub-species from other localities along the Queensland coast and states that the shell shows the presence of a spine which "is scarcely calcified, the chitinous dorsal covering being produced as seen in the figure". In fact, we are unable to detect any spine in this figure. According to Iredale "This genus is the only one yet known which shows the retention of the chitin", but he forgets *Hemisepius* which shows the same phenomenon.

He describes a new sub-species *wanda*, for specimens from Denham Bay, W. Australia, which has a long horny spine. In the figure (pl. V. figs. 9–11) the lateral margins of the shell are more rounded. The figured specimen measured 32 × 20 mm (W. = 62·5%). "The Western one, moreover, shows little calcification of the inner limbs, while in the eastern the inner limbs are well calcified. The ventral surface becomes more swollen with age and size, and a deep median furrow is developed. A larger specimen measured 38 mm by 23 mm, while a specimen from Stradbroke Island, South Queensland, measured 43 mm by 27 mm." From this text we cannot make out if this latter specimen belongs to the sub-species *wanda*; if this is the case it is not only a western form.

As *Sepia pfefferi* is only known from the type specimen, we do not know anything about the variation in this species and it seems pointless to us to describe every specimen which differs a little from the type specimen as a separate sub-species.

A second species of *Metasepia*, *M. tullbergi*, was described by Appellöf (1886, p. 26, pl. II, figs. 7–14) from Japan. Several authors (Ortmann, 1888, p. 656; Joubin, 1897, p. 103; Berry, 1912, p. 424; Okada, 1927, p. 179; and Sasaki, 1914, p. 621, 1929, p. 217, fig. 118, pl. XVIII, figs. 16–19) mentioned or described this species from Japanese localities.

Hoyle (1886, p. 148) enumerated the following differences between *Sepia pfefferi* and *S. tullbergi:* "In *Sepia pfefferi* the pits at the base of the funnel for articulation with the mantle are deepest in the middle, not at the anterior end as in *Sepia tullbergi;* there is no trace of any tubercles on the back or head; the teeth of the suckers on the sessile arms are finer and more acute, not so broadly triangular, as indicated in Appellöf's figure (pl. II, fig. 13); the tentacles are decidedly shorter and the large suckers on the club are not so conspicuous (compare pl. II, fig. 8, with pl. XXI, fig. 7 of the present report, where indeed they are hardly large enough); the denticulation of their horny rings, too, is much finer and not so regular. The shell agrees in almost every particular with Appellöf's description, except that the posterior extremity, although somewhat thickened, does not give rise to any structure at all like the horny lamella indicated by his figure (pl. II, fig. II, *a*)."

Although we did not examine any material of *S. tullbergi*, we think that the specific separation of both species of *Metasepia* is justified.

Sasaki (1929, p. 217) gave a very detailed description of *M. tullbergi*. It is worth mentioning that the male specimens do not show any hectocotylization of the arms. The tentacular club is much longer than in *M. pfefferi*, with the swimming-membrane extending far beyond the base of the club. The suckers are more numerous, apparently arranged in five or six series "unequal in size, four or five in the second row from the dorsal side of club being the largest of all, and three or four in the third row come next in size". The largest suckers are much smaller than in *M. pfefferi*.

As to the shell, its general form resembles that of *M. pfefferi* but "in the posterior extremity it forms on the dorsal surface a small, keel-like, vertical plate projecting dorsally and posteriorly".

60. *Sepia (Hemisepius) typica* (Steenstrup, 1875)
(Pl. 32, figs. 192–195; pl. 33, figs. 196 & 197)

Hemisepius typicus Steenstrup, 1875, p. 469, pl. I, figs. 1–10, pl. II, fig. 1; Hoyle, 1912, p. 281; Chun, 1915, p. 412, figs. 33 & 34; Smith, 1916, p. 25; Massy, 1927, p. 164; Voss, 1962*b*, p. 252.
Hemisepion typicum, Rochebrune, 1884, p. 78, pl. 3, fig. 1.
Hemisepius typicus var. *chuni* Thore, 1945, p. 50.

TYPE LOCALITIES: Table Bay; St. Francis Bay (var. *chuni*).
GEOGRAPHICAL DISTRIBUTION: South Africa.
MATERIAL:

a. Cape Natal, W. by N. 6½ miles (Pres. S. African Museum, No. 1262); B.M. 1926.10.20.7; 1 ♂ (in poor condition; det Massy as *Rhombosepion* sp. A. juv.).
b. Hout Bay (Pres. S. African Museum, P.F. 2273, No. 2273), shrimp trawl, 9–20 fms., sand and brackish shingle; B.M. 1926.10.20.29; 1 ♂ (det. Massy).
c. False Bay, Roman Rock, NW.¾ N.¾ miles (Pres. S. African Museum, P.F. 3046, No. 1259), large dredge, 18 fms., sand and rough shingle; B.M. 1926.10.20.28; 1 ♂ (det. Massy).
d. Langebaan Lagoon, Sta. XIV, 8 ft., L.B. 76, 15.vii.1946 (Pres. J. H. Day); B.M. 1958.8.20.21–30; 12 ♂, 3 ♀.
e. False Bay, 34°07′S., 18°31′E., 27½ miles, F.B. 1001, 22.ii.1947 (Pres. J. H. Day); B.M. 1958.8.20.10; 1 ♂ (M.L.d. = 19·5 mm).
f. Saldahana Bay, S.B. 79, 14.vii.1946 (Pres. J. H. Day); B.M. 1963102W.; 2 ♂ (M.L.d. = 21 mm).
g. False Bay, 34°09′S., 18°28′E., 23 miles, F.B. 1004, 29.iv.1948 (Pres. J. H. Day); B.M. 1958.8.20.13–18; 6 ♂, 1 ♀.

DESCRIPTION: As it is practically impossible to measure exactly the different parts of these tiny animals without damaging them, we give only a general description of the best preserved ones.

The male specimen (*b*) from Hout Bay has a dorsal mantle-length of 19 mm. Its dorsal mantle margin is slightly angular and the ventral one is strongly emarginate. The dorsal surface of the animal is slightly rugose, especially on the head and on the base of the arms. The rather wide fins, are fused at the posterior end of the body. The ventral surface of the mantle shows, on each side, an elongate, oval, slightly granular patch with 11 or 12 pores in its anterior half. The series of pores are situated at a distance from the fin base equal to the width of the fin.

The sub-equal arms are laterally compressed, with outer keels. The web is high, reaching about half-way up the arms, except between the ventral ones. All the arms have rather large, globular, biserial suckers. The dorsal arms bear 11 pairs of large suckers and a few small suckers at the tip; the large suckers are broadest at the base of the arm, diminishing towards the distal end, but the ninth and tenth pair are again slightly broader. The dorso-lateral arms show the same arrangement, but here the eighth and ninth pair are broader. On the ventro-lateral arms there are 13 to 15 pairs of large suckers, the eleventh and twelfth pair of which have the greatest diameter.

The right ventral arm has about 15 pairs of large suckers, the basal ones of which are much broader than on the other arms; they also diminish in size towards the distal end and the eleventh to the fourteenth pair are again larger.

The left ventral arm is hectocotylized: its basal two-thirds bear ten pairs of minute, widely-separated suckers, the intermediate space between the two series being transversely ridged. The distal third of this arm has five or six pairs of much larger suckers and a few minute suckers at the tip.

The tentacular club is short, crescent-shaped, with a high swimming-membrane, extending down the stem for about half the club-length. The dorsal protective membrane is wide and is separated from

the ventral one at the base of the club. The minute, sub-equal suckers are arranged in four or five longitudinal series.

The male (*c*) from False Bay has a dorsal mantle-length of 21 mm. The dorsal surface of the mantle is covered with small, widely-spaced tubercles. The ventral surface bears 12 pores on the left side, 13 on the right one, each pore being situated in the middle of a distinct roundish patch.

The hectocotylus has 12 pairs of minute suckers on its transformed part, the twelfth pair being slightly larger and followed by five pairs of normal big suckers and a few pairs of minute suckers at the tip.

Among the male specimens (*d*) from Langebaan Lagoon, one with a mantle-length of 20 mm has been illustrated on pl. 32, figs. 192 & 193.

The hectocotylus of a male with a mantle-length of 19·5 mm measures 11 mm (pl. 33, fig. 196) whereas the corresponding right arm has a length of 9·5 mm (pl. 33, fig. 197).

The female specimens are slightly longer, their dorsal mantle-length attaining 23·5–24 mm (pl. 32, figs. 194 & 195). The ventral part of the buccal membrane is very strongly developed as an expanded, strongly papillate patch with very high, crowded papillae.

All the arms have their suckers biserial; these gradually diminish in size from the base to the tip.

All the females have also the characteristic ventral pores, 12 or 13 on each side of the ventral side of the mantle.

The shell of the figured specimen (M.L.d. = 24 mm) has a length of 21 mm and a width of 12 mm. It is very acuminate at the anterior end, broadly rounded at the posterior end and nearly completely chitinized, the dorsal surface being without any trace of calcareous covering. The ventral face is difficult to describe, the anterior 8·5 mm is a thin, triangular, chitinous membrane, behind which begins the area which may be compared to the loculi of other *Sepiidae*, but which differs greatly.

The whole of this formation is reversed conical in outline, the anterior margin being slightly concave and the lateral margins convex. There are about 20 parallel striae; the last loculus, which is only a transverse band, is finely granulous. Behind the striae there is a thin, circular spot, which seems to represent the central part of an inner cone. The latter has short, rather broad, rounded limbs, which are completely fused with the very broad outer cone, this being continuous behind the inner cone as a broad, thin margin.

Remarks: In his original description, Steenstrup (1875, pl. 1, figs. 3–5) figured the dorsal and ventral faces of the shell of this species, but did not give a lateral view.

Rochebrune (1884, pp. 78, 79, pl. III, fig. 1), who has mentioned the species without having seen it, gives a lateral view of the shell which seems to be a pure invention. In fact, it shows a thick shell with the last loculus extending up to the anterior end of the shell; this figure is completely erroneous.

Thore (1945, p. 50) has mentioned and described some specimens from Table Bay and Oude Kraal. He thinks that "we have to postulate a constant difference in size between the eastern and the western forms of *Hemisepius*, the latter being largest".

It seems to us very hazardous to make such a statement on the few specimens known or described up to the present; in fact only one specimen from the eastern region (St. Francis Bay) was described by Chun (1915, p. 411). In our opinion it is not at all "obvious that, at least, we have to do with two different varieties of *Hemisepius typicus*", as Thore (1945, p. 52) thinks. Chun's figure 34 of the hectocotylus is rather schematic and it is not unlikely that some of the big suckers at the basal part of the distal portion were lost. Until more specimens are known, we do not see that a case has been made for creating a "var. *chuni*" for the animals from the eastern area.

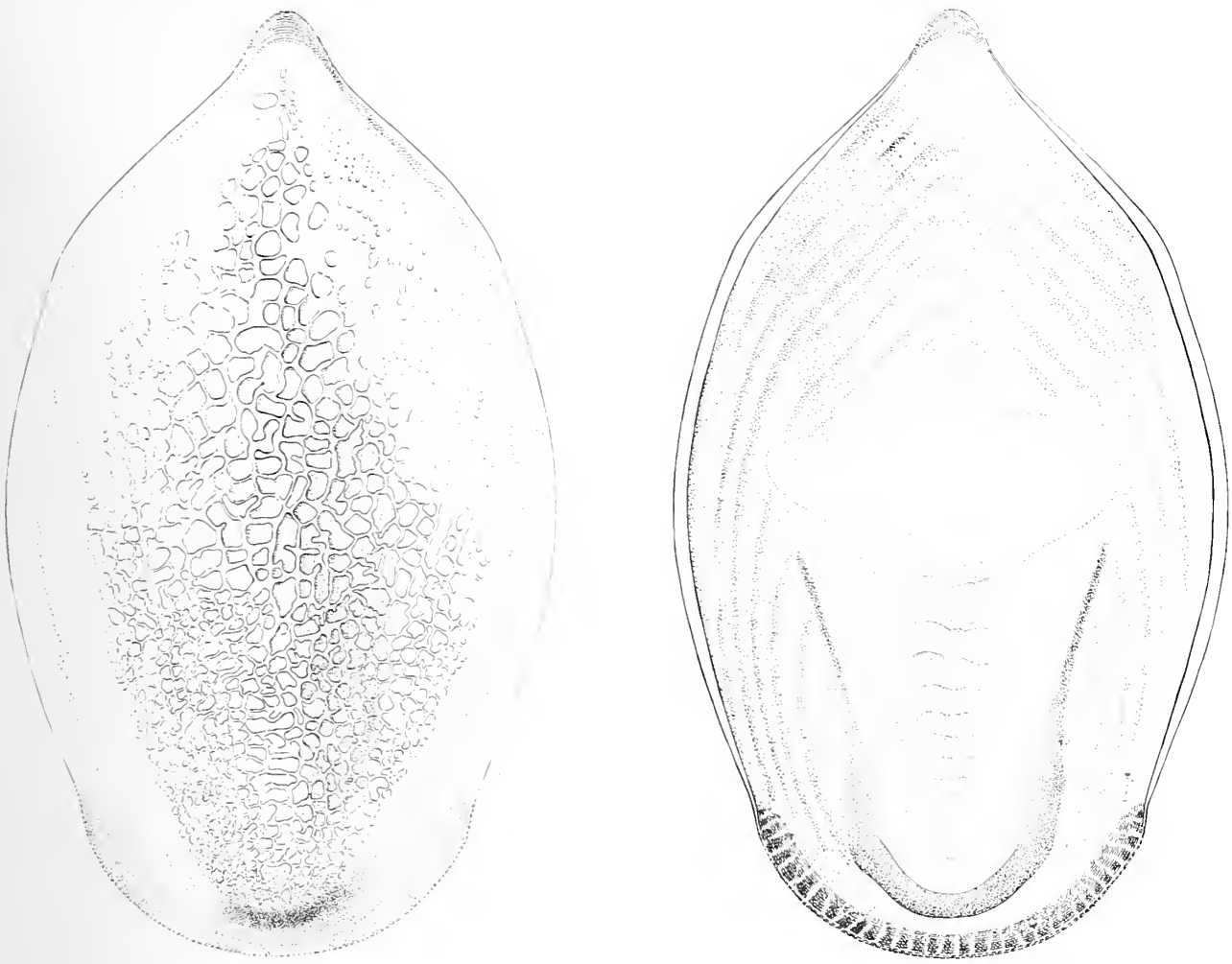


FIG. 1. *Sepia* (*Hemisepius*) *dubia* sp. nov: dorsal and ventral views of shell (L=14·5 mm).

61. ***Sepia (Hemisepius) dubia*** sp. nov.
(Pl. 34, figs. 198–201; pl. 46, fig. 272; text-fig. 1)

TYPE LOCALITY: False Bay.

MATERIAL:

a. False Bay (Univ. Cape Town Ecol. Surv.), F.B. 1007, 18.iii.1950; B.M. 1963103W.; 1 ♀ (holotype).

DESCRIPTION: The animal is small (dorsal mantle-length, 17 mm; ventral, 15 mm) and broad (width: 11·5 mm). The dorsal surface of mantle, head and arms is covered with well spaced, round papillae, creating a very rugose appearance. The dorsal mantle-margin is slightly convex and the ventral margin is deeply emarginate around the funnel (pl. 34, figs. 200 & 201). The ventral surface of the mantle is smooth, with a thick, fleshy keel, parallel to the outer margin, as in *Hemisepius typicus*, but without any pores. On the dorsal surface of the mantle, approximately in the middle, there are two oval patches of contracted papillae, one on each side of the median line, and a third one anteriorly near the mantle-margin.

All the arms are laterally compressed, sub-equal in length, keeled on their outer sides and with narrow protective membranes. The web is very high between the dorsal and lateral arms, reaching

half way up the arms; it is much lower between the ventro-lateral and ventral arms and non-existent between these last. The arm-suckers are rather small and biserial.

The tentacular stem is triangular in cross-section; it is flattened on the inner surface and roundly angular on the outer one. The club is small, crescent-shaped, with a well-developed swimming-membrane, extending beyond the base of the club for about half its length. (Pl. 46, fig. 272). The dorsal protective membrane is wide and is separated from the ventral one at the base of the club. The minute, sub-equal suckers are arranged in four or five longitudinal series.

The shell is broadly oval, acuminate at the anterior end, but less so than in *Hemisepius typicus* and is broadly rounded behind (pl. 34, figs. 198 & 199 and text-fig. 1). It is a low dome-shape in the middle but is flatter near the margins. Nearly the whole dorsal surface is calcareous, with a reticulate pattern. There is no spine. The ventral surface is strongly concave and spoon-shaped. The central part has a reversed conical shape and is slightly higher than the surrounding part; it occupies a little more than half the shell-length, as in *Hemisepius typicus*. The last loculus is trapezoid, widest at the anterior margin. This last loculus represents about half the length of the striated area. Behind the last loculus, the striated area occupies only the central third portion of the whole inner zone, and is flanked by two broad, smooth, marginal areas. The striae, about 15 in number, are widely-spaced, transverse, nearly straight, being only slightly wavy. There is a distinct inner cone, brownish in colour in alcohol, with rather broad limbs, that are completely fused to the outer cone; its posterior part surrounds a very shallow depression. The broad outer cone surrounds completely the inner one.

The shell measures about 14·5 × 9 mm; unfortunately it was brittle and was slightly damaged during extraction.

Remarks and relationship: This species certainly differs from *Hemisepius typicus* in having a tuberculate skin and in the absence of ventral pores on the mantle; the tentacular clubs are exactly alike.

The shell is of the *Hemisepius* type, but differs from all the specimens of *H. typicus* that we examined, in the calcareous covering of the dorsal surface and in possessing a very distinct inner cone.

62. ***Sepia robsoni*** Massy, 1927
(Pl. 46, fig. 279)

Rhombosepion robsoni Massy, 1927, p. 159, pl. XVII.

Type locality: Hout Bay.
Geographical distribution: South Africa.
Material:

a. Hout Bay (P.F. 2273, No. 1282), 9–20 fms., fine sand and shingle; B.M. 1926.10.20.8; 1 ♂ (holotype).

Description: This tiny species has been well described by Massy. Its mantle length is only 17 mm, the specimen being an adult male. The dorsal mantle-margin is slightly convex. The ventral surface is much like that of *Hemisepius typicus* with the fleshy ridge and the same deeply emarginate mantle-margin, but there is no trace of any pores. The dorsal arms have the finger-like tips, devoid of suckers, described by Massy (1927, p. 159), and eight pairs each of sub-equal suckers, the last pair being slightly smaller. The dorso-lateral arms have eight pairs each of sub-equal suckers, the distal ones being slightly larger with narrow apertures and rings, and are followed distally by a few small suckers. The ventro-lateral arms each have nine pairs of big sub-equal suckers. The left ventral arm is hectocotylized as in *Hemisepius typicus*, with ten pairs of minute suckers, occupying the proximal

three-quarters of the arm, but are without the enlarged suckers at the base of the distal part. The right ventral arm bears seven pairs of rather large suckers, covering more than half the arm; the ventral ones are larger than the dorsal ones and are much larger than those of the other arms. All the arm-suckers are rather globular.

As in *Hemisepius typicus*, the web reaches half way up the arms between the dorsal, dorso-lateral and ventro-lateral arms; between the ventro-lateral and ventral arms it is much lower and is completely lacking between the ventral ones.

The tentacular club is exactly like that of *Hemisepius typicus:* it is crescent-shaped, about $2\frac{1}{2}$ mm long, and has a very broad swimming-membrane, extending beyond the base of the club for about half the length of the latter (pl. 46, fig. 279). The dorsal protective membrane is very broad at the base of the club. The sub-equal suckers are arranged in transverse rows of four to six, the median ones being slightly larger than the other ones.

The completely chitinized (? decalcified) shell is in poor condition. Its anterior part is strongly acuminate and resembles that of *Sepia hieronis*.

Remarks: According to Massy (1927, p. 159) *S. robsoni* resembles *S. hieronis* (see p. 112) "but is distinguished from it by having grooved suckers (smooth rings) which are placed in 2 rows on all the arms, and none is enlarged in the male". There are a few tubercles along the outline of the shell and on the head. The shell somewhat resembles that of *S. insignis* (see p. 114) but the latter is even more acuminate anteriorly and seems to be much wider in its posterior part.

In the original description it was stated that the shell was dissolved, but we have no proof that it was ever calcified.

In our opinion this species is closely related to *Hemisepius typicus* but more material is needed to determine its exact relationship.

63. ***Sepiella cyanea*** Robson, 1924
(Pl. 36, figs. 208–215)

Sepiella cyanea Robson, 1924, p. 13; 1924*a*, p. 648, figs. 25–27, pl. II, fig. 6; Adam, 1939*c*, p. 109, figs. 14A–B, pl. IV, figs. 3 & 4.
? *Sepiella obtusata* Massy, 1928, p. 95 (*non* Pfeffer, 1884).
Sepia sp. *a*. Voss, 1962, p. 3.

Type locality: Natal.
Geographical distribution: Natal.

Material:

a. Natal (Sta. 476), 20 fms.; B.M. 1924.9.9.40; 1 ♂ (lectotype, here designated)[1].
b. Port Elizabeth (Spencer); B.M. 1890.12.14.46–48; 3 shells.
c. Port Elizabeth (Ponsonby); B.M. 1891.6.13.40; 1 ♀.
d. Algoa Bay (Spencer); B.M. 1895.12.18.1; 1 ♀.
e. Durban (Chubb); B.M. 1963104W.; 1 ♂.
f. Isipingo (Falcon); B.M. 1952.11.21.39–40; 2 shells.
g. Nosy N'Tangam, 30.xi.1959 (Cherbonnier); I.R. Sci. Nat. Brussels, I.G. 22.037; 5 ♂, 1 ♀, 4 juv. (♀ ?).

[1] The second specimen mentioned by Robson could be traced neither in the British Museum, the South African Museum nor at the headquarters of the Marine Biological Survey of South Africa.

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
a	♂	74	74	45	23	41	93	15	41
c	♀	75	80	53	24	40	87	13·5	36
d	♀	71	84	45	27	42	95	14	38
e	♂	75	81	41	24	39	85	9·5	41
g	♂	56	88	57	25	52	100	19·5	36
	♂	55	87	56	25	49	98	18	35
	♂	53·5	86	60	26	49	98	20	36
	♂	50	86	58	26	52	98	20	38
	♂	48	86	60	27	50	92	12·5	40
	♀	69	86	52	25	49	100	19	29
	♀?	37	87	65	27	51	100	19	27
	♀?	37	87	59	27	51	100	19	27
	♀?	37	84	65	27	51	95	16	27
	♀?	29	89	64	31	55	91	12	28

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
a	♂	74	41	47	61	81	19	1·35	0·35
c	♀	75	33	36	47	146	22·5	1·1	0·35
d	♀	71	39	39	48	—	22·5	—	—
e	♂	75	41	45	55	106	17·5	1·6	0·35
g	♂	56	36	46	54	—	23	2·1	0·55
	♂	55	36	44	49	—	22	2·2	0·55
	♂	53·5	36	43	50	—	20	2·1	0·55
	♂	50	38	48	54	—	24	2·0	0·5
	♂	48	40	50	56	—	21	2·1	0·45
	♀	69	29	30	38	—	24·5	1·45	0·7
	♀?	37	27	27	35	—	—	1·5	—
	♀?	37	27	27	38	—	24	1·35	0·4
	♀?	37	27	27	38	—	—	1·35	—
	♀?	29	28	31	35	—	—	1·7	—

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	L.loc.
f		80	32·5	12	60	34
f		76	31·5	12·5	58	32
c	♀	74	30·5	11	51	37
d	♀	70	31·5	12	53	39
g	♀	69	35·5	13	58	33
a	♂	69	29	10	58	29
g	♂	54	33	14	56	28

DESCRIPTION: The specimens in the British Museum are in rather poor condition and the following description is based principally on a series of well preserved animals, from Nosy N'Tangam, in the Royal Institute of Natural Sciences in Brussels.

The body is thick, cylindrical in its anterior half, obtusely rounded or slightly acuminate behind. The dorsal mantle-margin is angular in the middle and concave behind the eyes; the ventral margin is slightly emarginate around the stout funnel. The fins are broad, arising a few millimetres behind the mantle-margin and extending beyond the posterior end of the mantle where they are fused at their base.

The head is short and slightly wider than the mantle-opening. The whole dorsal surface (in alcohol) is of a bluish grey or brown colour with a vague indication of dark round patches at the base of the fins in the males.

The arms are short, stout at their base and laterally compressed each with a keel on the outer side. In the male the arms are relatively much longer than in the female. The web is low, sub-equal, slightly less developed between the dorsal and dorso-lateral arms and absent between the ventral arms.

The suckers are quadriserial, those of the male are each armed with a dozen strong, sharp teeth on the distal half of the chitinous ring; those of the female are practically smooth. In the female the protective membranes are more developed than in the male and cover the distal suckers.

The left ventral arm of the male is hectocotylized in its basal half where it is wide with a strong dorsal protective membrane which is folded over the dorsal suckers. The whole transformed portion (pl. 36, fig. 214) bears two dozen alternate pairs of minute suckers; the two ventral series are close together, nearly forming a single series; the dorso-lateral series are near the base of the protective membrane and the dorso-median one approximately in the middle of the transformed part. These pairs of suckers are placed on thick, fleshy ridges which anastomose with each other.

The tentacular stem is triangular in cross-section with a rounded keel on the outer side and a flat, transversely-striated, inner surface, which is limited by two membraneous ridges, these being the continuation of the protective membranes of the club. The swimming-membrane of the latter is not very broad and barely reaches the base of the club. The protective membranes are narrow. The minute, sub-equal suckers are arranged in about 12 longitudinal series in both sexes (pl. 36, fig. 215). Their chitinous rings are each armed with a few, blunt, spaced teeth.

The shell of the female is broadly rounded posteriorly and is acuminate in its anterior half (pl. 36, figs. 212 & 213). The dorsal surface is finely granular, with a broad median rib. The ventral surface shows a rather irregular, narrow and shallow median furrow and some other irregular radiating furrows, which give a wavy appearance to the convex striae.

The last loculus is flatter, with a shallow depression. The inner cone is V-shaped with narrow limbs. The outer cone is chitinous and broadly rounded behind the inner cone.

The shell of the male is much narrower than that of the female; it is widest in the middle and acuminate towards both ends (pl. 36, figs. 208 & 209). The ventral surface is much thicker and the inner cone is less developed. In both sexes the extreme posterior end of the inner cone forms a small rounded knob. The outer cone is narrower and slightly acuminate at the posterior end.

Remarks: Unfortunately Robson did not describe the shells in detail and did not figure them. As the female syntype seems to be lost it is impossible to know more of its shell than that the latter was relatively broader (32%) than the shell of the male (29%). All the above-mentioned specimens seem to belong to *Sepiella cyanea*, as well as the shells from Ambavanibé, Madagascar, described by Adam (1939*c*, p. 110, fig. 14, pl. IV, figs. 3 & 4).

Sepiella cyanea seems to be closely related to *S. ornata* (Rang) from the West African coast (see Adam, 1952, p. 37, figs. 12 and 13, pl. II, figs. 3–5), but the shell of the latter (pl. 35, figs. 203–207), is distinctly different, the width being 24–27% of shell-length in the males and 27–30·5% in the females, whereas the striated area is shorter. The general outline of the shell of *S. ornata* is more elongate oval and not so broad in the posterior part.

Compared with the shell of *Sepiella weberi* Adam, 1939 (pl. 37, fig. 216–219). the posterior part of the striated area is much more acuminate in *S. cyanea*, especially in the male.

64. ***Sepiella inermis*** (Férussac & d'Orbigny, 1835–1848)
(Pl. 38, figs. 222–227; pl. 40, figs. 233 & 234)

Sepia inermis Férussac & d'Orbigny, 1835, pl. 6*bis*; 1848, p. 286, pl. 20, figs. 1–9.

Sepia (*Sepiella*) *inermis*,Tryon, 1879, p. 196, pl. 91, fig. 423, pl. 92, figs. 424-429; Steenstrup, 1880, pp. 347, 356, figs. 1–8.
Sepiella inermis, Rochebrune, 1884, p. 88; Goodrich, 1896, p. 5; Joubin, 1898, p. 25; Hoyle, 1905, p. 982, fig. 152; Massy, 1916, p. 231, pl. XXIII; Winckworth, 1926, p. 330; Adam, 1939*b*, p. 65; 1939*c*, pp. 93, 104, figs. 1–5, pl. IV, figs. 5 & 6; Satyamurti, 1956, p. 178, pl. XXVI, fig. 2*a–b*.
Sepia (*Sepiella*) *microcheirus* Gray, 1849, p. 107.
Sepiella microcheirus, Adam, 1939*c*, p. 105.
Sepiella curta Pfeffer, 1884, p. 13, figs. 16, 16*a*; Wülker, 1910, p. 20; Adam, 1939*c*, p. 106.
Sepiella maindroni Rochebrune, 1884, p. 89; Adam, 1939*c*, p. 106; 1944, p. 224.
Diphtherosepion martini Rochebrune, 1884, p. 81; Adam, 1944, p. 221.
Sepia tourannensis Eydoux & Souleyet, 1852, p. 33, pl. 3, figs. 6–12; Adam, 1939*c*, p. 107.
Rhombosepion touranense, Rochebrune, 1884, p. 84; Adam, 1944, p. 222.
Sepia affinis Eydoux & Souleyet, 1852, p. 35, pl. 3, figs. 13 & 14 (*non* Férussac, 1826).
Sepiella affinis, Adam, 1939*c*, p. 107.

TYPE LOCALITIES: Batavia; Bombay; Pondicheri; Coromandel Coast (*S. inermis*); India (*S. microcheirus*); Java (*S. curta*); Pondicheri (*S. maindroni*); Sumatra (*S. martini*); Touranne Bay (*S. tourannensis*); Touranne Bay (*S. affinis*).

GEOGRAPHICAL DISTRIBUTION: Indian Ocean.

MATERIAL:

Animals:

a. India (General Hardwicke); 1 ♀ (det. Gray, 1849 as *Sepia microcheirus*), B.M. 1963121W.
b. India(?) (Mr Leadbeater); 1 ♂ (det. Gray, 1849 as *Sepia microcheirus*), B.M. 1963122W.
c. Bental (General Hardwicke); 1 ♀ (det. Gray, 1849 as *Sepia microcheirus*), B.M. 1963123W.
d. India (General Hardwicke); 1 ♀ (det. Gray, 1849 as *Sepia microcheirus*), B.M. 1963124W.
e. Penang (Cantor Coll., East India Museum); B.M. 1860.6.2.86 (part), re-registered 1947.11.4.2; 1 ♂ (M.L.d. = 44 mm).
f. Sumatra (Coll. Carl Bock); B.M. 1879.10.4.1–2; 2 ♀.
g. Ramesvaram Island, Madras (Thurston); B.M. 1894.9.6.2–4; 1 ♂, 1 ♀.
h. Sandheads, R. Hooghly, Bengal; 5.iv.1927 (Pres. Director, Indian Museum); B.M. 1947.5.16.9; 1 sp. (identified as *S.* ? *aculeata*).
i. Aden, Feb., 1949 (Coll. Fraser-Brunner); B.M. 1963105W.; 1 ♀.
j. Mukalla, S. Arabia, Dec., 1948 (Coll. Fraser-Brunner); B.M. 1963106W.; ♀.

Dry shells:

k. India (General Hardwicke); 3 shells (det. Gray, 1849 as *Sepia microcheirus*), B.M. 1963125W.
l. Sarawak (Coll. Bartlett) (Santubang and Buntal); B.M. 1894.7.14.7–9; 3 shells.
m. Sarawak (Coll. Bartlett) (Santubang and Buntal); B.M. 1894.7.14.47–48; 2 shells.
n. Madras, 12.i.1936 (Winckworth); B.M. 1948.7.9.8–17; 10 shells.
o. Gopalpur, May, 1929; B.M. 1952.11.21.28–29; 2 shells.
p. Ennûr, 10.ii.1925; B.M. 1952.11.24.9–11; 3 shells (♀).
q. Puri, 22.iv.1929; B.M. 1952.11.24.12–15; 4 shells.
r. Ennûr, 10.ii.1925; B.M. 1952.11.24.16–19; 4 shells.
s. Connanore, 1.xii.1924; B.M. 1952.11.24.20; 1 shell.
t. Madras beach, 15.i.1927 and 23.x.1927 (largest specimen); B.M. 1952.11.24.21–23; 3 shells.
u. Madras, 18.ix.1930; B.M. 1952.11.24.75–76; 1 juv. shell (removed from box with *Sepia winckworthi*).
v. Gopalpur, Gonjam, 25.v.1929; B.M. 1952.12.30.39–47; 9 shells.
w. Tellicherry, 1.x.1930; B.M. 1952.12.30.48–51; 4 shells.
x. Madras, 12.i.1936; B.M. 1952.12.30.52–55; 4 shells.
y. Juhu, 11.xi.1935; B.M. 1952.12.30.58; 1 shell.
z. Madras, 12.i.1936; B.M. 1952.12.30.59–64; 6 shells.

MEASUREMENTS:

ANIMAL (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
i	♀	93	92	48	27	43	100	16	32

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
i	♀	93	34	37	45	130	30	1·5	0·55

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	L.loc.	Observations
i	♀	90	37	15	50	33	pl. 38, figs. 225 & 226
f	♀	69	39	12	55	30	pl. 40, fig. 233; pl. 38, fig. 222.
f	♀	68	38	13	56	31	
r	♀	39	40	15·5	41	49	
r	♂	48	40	13·5	54	31	
q		86	38	13	60	27	
w		84	36	13·5	50	39	
s		84	36	13	59	29	
p		78	41	15	51	33	pl. 38, figs. 223 & 224
w		75	37	13	59	32	
n		75	39	12·5	56	33	
x		74	41	13·5	58	30	
w		73	36	12	56	34	
x		70	43	14	57	31	
v		69	42	13	48	39	
v		69	42	13	56	35	
o		67	39	13·5	51	39	
v		66	42	13	58	41	
x		65	40	15·5	49	42	
p		65	43	15·5	43	43	
n		65	42	16	49	40	
x		63	42	14	54	35	
v		60	40	14	48	50	
o		59	42	16	48	44	
n		59	42	14·5	51	39	
q		58	40	14·5	65	21	
w		56	36	13	59	30	
q		55	37	14	64	24	
q		54	39	15	67	26	
v		52	40	14·5	48	40	
v		51	36	14	47	41	
p		51	35	14	65	29	
n		50	42	15	46	42	
z		50	36	16	56	34	
n		49	39	14	59	31	
z		47	41	15·5	51	36	
n		46	35	16	48	39	
z		43	38	16	44	44	
y		42	37	15·5	50	40	
n		39	40	15·5	44	46	
z		36	39	15·5	42	50	
t		35	41	14	43	49	
r		33	42	15	42	48	

Loc.	Sex	L. in mm	W.	Th.	Str.z.	L.loc.	Observations
n		32	41	16	44	47	
t		32	42	16·5	44	50	
n		31	43	17	45	48	
r		30	42	15·5	43	50	
z		29	40	16	45	52	
t		29	40	16	41	48	
j		28·5	39	16	39	47	
n		26	42	17	39	50	
z		26	44	19	—	—	

DESCRIPTION: With the exception of the big female specimen from Aden (*i*), the animals are in more or less poor condition and do not allow a detailed description.

This specimen from Aden is the longest ever recorded of *Sepiella inermis*.

The body is broadly oval, the dorsal mantle-margin is angularly rounded and the ventral margin is slightly emarginate (pl. 38, fig. 227).

The short, stout arms are laterally compressed and the dorsal ones are indistinctly keeled; the others have outer keels which are particularly developed on the ventral arms. The protective membranes are well developed. The suckers are quadriserial.

The sub-equal web is rather low and is absent between the ventral arms.

The swimming-membrane of the tentacular club is slightly shorter than the club-length. The narrow protective membranes are separated at the base and continue as low membraneous ridges on the flattened inner surface of the stem, whose outer surface is rounded. The minute, sub-equal suckers are arranged in 24 series in the middle part of the club (pl. 40, fig. 234).

The shell of this animal is broadly oval; its ventral surface is strongly convex in lateral view. Its dorsal surface is granulous with a distinct but low median rib. The ventral surface is thick in the middle, with a narrow, median groove and several, faint, radiating furrows on the striated area (pl. 38, figs. 225–226). The anterior portion of the last loculus is concave. The general outline of the striae is strongly convex, but they have a wavy outline due to the radiating grooves. The inner cone forms a thick, narrow, rounded posterior ridge; its lateral limbs are wider but flatter and indistinct. The outer cone forms a semi-circular wing-like posterior portion.

As to the other specimens and to the dry shells, the young shells show the striated area to be much narrower than the last loculus, which continues down both sides to the inner cone. In these young shells the striated area is concave in its general appearance, with the narrow groove in the middle of the convex central portion.

The inner cone of the female shell forms a narrow, thick, rounded, posterior ridge, raised in the centre as a rounded knob. In most specimens the limbs of the inner cone turn abruptly outwards at some distance from the posterior end, become first broader and thicker and then progressively flatter and fuse with the outer cone on to the smooth narrow zones which separate the striated area from the outer cone. In some shells (pl. 38, fig. 224) the inner cone widens immediately, becoming fused to the outer cone; the striae of the striated area continue on these expanded limbs. In the narrower shells of the males these formations of the inner cone are less distinct.

The left ventral arm of the male is hectocotylized in its proximal half, with ten transverse rows of minute suckers.

REMARKS: On the first examination of the big specimen from Aden we thought it might be a new species but after a thorough comparison with *Sepiella inermis* there remained only one difference—the high number of minute suckers on the tentacular club. Adam (1939*c*, p. 96) described the number of suckers in an oblique transverse row as 13 to 14 in the females, 16 in the males, but according to Massy (1916, p. 234) "The very numerous and minute club suckers are distributed in no particular order".

The females from Sumatra (*f*) possess 20 to 24 suckers in the transverse rows in the middle of the club.

As the shells are completely alike and the number of club-suckers seems to vary a good deal, we have finally included this specimen in *Sepiella inermis*.

It is worth mentioning that Adam (manuscript in preparation) found a young *Sepiella* among the collections from the Hebrew University of Jerusalem, made in the southern part of the Red Sea. This specimen does not seem to differ from *S. inermis*.

As to the different species enumerated as synonymous, Steenstrup (1880, p. 356) stated that *Sepiella microcheirus* Gray represented the female of *S. inermis*. Among the original material of *S. microcheirus* are two males and two females, but both belong without any doubt to *S. inermis*.

After having examined the types of *S. curta* Pfeffer, Adam (1939*c*, p. 106) considered this species to be synonymous with *S. inermis*.

Adam (1939*c*, p. 106) first thought *S. maindroni* Rochebrune, 1884, to be a male specimen of *S. inermis*, but the type-specimen proved to be a female of that species (Adam, 1944, p. 224). As we mention on p. 130, the other references concerning *S. maindroni*, from Japanese localities, probably refer to *S. japonica*.

The type specimen of *Diphtherosepion martini* Rochebrune, 1884, is a male of *S. inermis* (Adam, 1944, p. 221).

Sepia tourannensis and *S. affinis* Eydoux & Souleyet, 1852, which Rochebrune (1884, p. 84) had already considered to be identical and which he placed in his genus *Rhombosepion*, belong without any doubt to *S. inermis* (Adam, 1944, p. 222).

As for *Sepiella melwardi* Iredale, 1954, the only species hitherto described from Australian waters (Condon Bay, Melville Island, Northern Territory), its shell strongly resembles that of *S. inermis*, but in both sexes it is relatively narrower: that of the type female measuring 53 × 18 × 6·6 mm (W. = 34%; Th. = 12%), that of the male 44 × 14 × 6 mm (W. = 32%, Th. = 13·5%). According to the author (p. 79) the male shells show a notch in the posterior fan, those of the females lack such a notch. We wonder if this notch is really characteristic or if the posterior part of the outer cone had simply split on drying.

The species was based only on stranded shells. Iredale (1954, p. 79) mentions a single animal (dredged in 40 fms. S.E. of Lesueur Island, Australia) the bone of which was decalcified, but which probably belongs to *Sepiella melwardi*. As he did not describe this animal we are unable to decide how nearly related this species is to *S. inermis*. Iredale himself did not compare his species with other species of *Sepiella*, he only mentions that "Adam has reviewed the named species, amalgamating some forms irrespective of geographical distribution and then naming a new species, *S. weberi* from the Moluccas"[1]. But he does not try to refute Adam's arguments, unless he considers geographical distribution to be a specific character. On the other hand Adam's conclusions (1939*c*, p. 114) with which we completely agree, result in a nearly complete geographical separation of the species he recognized (see his map of this distribution, fig. 17, p. 115), viz.:—

Sepiella ornata (Rang): West Africa, from Mauritania to Angola;

Sepiella cyanea Robson: South East Africa;

Sepiella inermis (Férussac & d'Orbigny): Indian Ocean from the Red Sea to Indonesia and Cochin China;

Sepiella japonica Sasaki: Chinese and Japanese waters;

Sepiella ocellata Pfeffer is only known from a single male specimen from Java. Its shell (pl. 35, fig. 202) strongly resembles that of *S. ornata* but it is still narrower. The tentacular club has only 8 to 10 longitudinal series of minute, sub-equal suckers.

[1] Adam (1939*c*, p. 98) described this species from Timor and Soemba which do not belong to the Moluccas but to the Lesser Soenda Islands.

Sepiella weberi Adam, from Timor and Soemba (pl. 37, figs. 216–219), strongly resembles *S. cyanea* but the posterior portion of the striated area is much more acuminate in the latter species. The tentacular club has, in both sexes, 10 to 12 longitudinal series of minute, subequal suckers.

As Adam (1939*c*, p. 101) pointed out, Rochebrune (1884) classified *S. inermis* and its synonyms in three different genera, viz.:– *Diptherosepion*, *Sepiella* and *Rhombosepion*.

65. ***Sepiella japonica*** Sasaki, 1929
(Pl. 39, figs. 228–231)

Sepiella japonica Sasaki, 1929, p. 219, fig. 170,[1] pl. XVIII, figs. 20–23, pl. XIX, fig. 28; Yasumoto, 1938, p. 45, figs. 1 & 2; Adam, 1939*c*, p. 110, fig. 15A.
? *Sepiella ovata* Pfeffer, 1884, p. 14, figs. 18 & 18*a*; Adam, 1939*c*, p. 112, fig. 16B.[2]
? *Sepiella obtusata* Pfeffer, 1884, p. 15, figs. 19 & 19*a*; Adam, 1939*c*, p. 113, fig. 15B.
? *Diphtherosepion dabryi* (pars) Rochebrune, 1884, p. 81; Adam, 1944, p. 221.
? *Sepia sinensis* Férussac & d'Orbigny, 1835, pl. IX, figs. 1 & 2; 1848, p. 289; d'Orbigny, 1845, p. 299.
? *Sepia* (*Sepiella*) *sinensis*, Gray, 1849, p. 106.
? *Sepiella sinensis*, Berry, 1912, p. 417; Sasaki, 1914, p. 623; Adam, 1939*c*, p. 114.
Sepiella maindroni, Hoyle, 1886, p. 149, pl. XXII, figs. 1–10; Wülker, 1910, p. 20; Berry, 1912, p. 424; Sasaki, 1914, p. 621, fig. 1; Ishikawa, 1924, p. 195 (*non* Rochebrune, 1884).
Sepiella inermis, Joubin, 1897, p. 103; Berry, 1912, p. 424; Sasaki, 1914, p. 622 (*non* Férussac & d'Orbigny, 1835).
? *Sepia recurvirostra*, Hoyle, 1886, p. 137 (*non* Steenstrup, 1875).
Sepia sp. *c* Voss, 1962, p. 3.

TYPE LOCALITY: Etchû Province, Japan.
GEOGRAPHICAL DISTRIBUTION: Chinese and Japanese seas.
MATERIAL:

a. Canton market (Pres. Tradescant Lay); 2 salted specimens. (det. Gray, 1849, p. 107, as *Sepia* (*Sepiella*) *sinensis*.) B.M. 1963127W.
b. China (Pres. Card); 1 ♀. (det. Gray, 1849, p. 107 as *Sepia* (*Sepiella*) *sinensis*.) B.M. 1963128W.
c. Chefu, China (purchased Swinhoe); B.M. 1873.9.22.1; 1 ♀.
d. Chee-foo, China (purchased Swinhoe); B.M. 1874.1.24.9; 1 ♂.
e. Challenger Exp. Sta. 207, 12°21′N., 122°15′E., China Sea[3], 16.i.1875, 700 fms.; B.M. 1889.4.24.76; 1 broken shell. (det. Hoyle as *Sepia recurvirostra* ?)
f. Challenger Exp., Inland Sea, Japan; B.M. 1890.1.24.12; 1 ♀. (det. Hoyle as *Sepiella maindroni* ?)
g. Inland Sea, Japan (Pres. Gordon Smith); B.M. 1904.10.28.1–2; 2 ♀.

MEASUREMENTS:

ANIMALS (IN % OF DORSAL MANTLE-LENGTH)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L. I
b	♀	89	83	49	33	39	84	11	22
g	♀	114	87	44	26	33	94	15	40
	♀	140	86	41	21	36	89	13·5	30

[1] This figure is indicated as "*Sepiella heylei* n.n.".
[2] In this paper the figure was erroneously referred to as 16A in the indications between brackets under 12. *Sepiella ovata* (p. 112).
[3] According to Hoyle (1886, p. 137) the locality is: "off Tablas Island".

Loc.	Sex	M.L.d. in mm	A.L. II	A.L. III	A.L. IV	T.L.	T.cl.	S.a.	S.t.
b	♀	89	25	27	29	118	27	—	—
g	♀	114	40	40	44	—	—	1·15	0·35
	♀	140	30	30	35	—	—	1·0	—

SHELLS (IN % OF SHELL-LENGTH)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	L.loc.	Observations
b	♀	86	28·5	14	49	42	
c	♀	99	27·5	13	54	35	
d	♂	126	31	12	52	36	pl. 39, figs. 228 & 229
f	♀	120	29	13	57	32	
g	♀	138	30·5	12·5	52	36	pl. 39, figs. 230 & 231

DESCRIPTION: The animals are in rather poor condition, the most recent ones in the collection having been collected nearly 60 years ago, although it seems to be one of the most common species in Japan.

The dorsal mantle-margin is angular and projects forward strongly. All the arms are laterally compressed and keeled on their outer sides. The suckers are quadriserial, those of the male being each armed with 15 to 20 long, close-set teeth on the distal margin of the chitinous ring. The web is highest between the dorsal and lateral arms. The tentacular club is long and covered with about 20 longitudinal series of minute suckers.

The left ventral arm of the male is hectocotylized, its basal part is transformed, bearing a dozen transverse rows of minute suckers, placed on a grooved surface. Of the four longitudinal series of these suckers, the two ventral ones are close together, the third row is in the middle and the fourth situated between the latter and the dorsal margin. The transformed portion measures only one-third to one quarter of the arm-length.

The shells (pl. 39, figs. 228–231) do not reveal any sexual difference. The finely granulous dorsal surface is rather convex with an indistinct median rib. The ventral surface is convex except at the posterior end of the striated area and at the flattened anterior portion of the last loculus which is concave in the middle. The striae are convex in general outline, but irregularly wavy due to the faint radiating grooves, the median one of which may be more pronounced. The inner cone is V-shaped with very narrow limbs and a rounded posterior knob. The outer cone is long and broad in its posterior portion extending far beyond the inner cone and is regularly rounded behind.

REMARKS: The specimens described above agree very well with Sasaki's detailed description (1929, p. 219). Apparently there is a difference in the dentition of the arm-suckers, but we are sure that there is a printing error in the original text. After having described the suckers of the males as being dentate, the author states: "In mature males the teeth are united together so as to render the ring smooth on the whole margin." In fact this applies to mature females, because Sasaki (pl. XVIII, fig. 20), figures the strongly dentate sucker of a mature male.

Although several earlier authors have used the name *sinensis* for this species, we have adopted Sasaki's name *Sepiella japonica* in order to avoid any possible confusion.

As Adam (1939*c*, p. 113) indicated, *Sepiella ovata* Pfeffer, 1884, from an unknown locality, is probably identical with *S. japonica*, but the poor state of the type did not allow a definite conclusion. The same is true of *Sepiella obtusata* Pfeffer, 1884, also from an unknown locality. The specimens mentioned by Massy (1928, p. 95) from Tongaat Beach, Natal, probably belong to *S. cyanea* and not to *S. obtusata*.

Diphtherosepion dabryi Rochebrune, 1884, was based on different species, one of them being *Sepia esculenta* Hoyle, another probably *Sepiella japonica*; the original description of the shell seems to apply to the former species (see Adam, 1944, p. 221).

The type of *Sepiella maindroni* Rochebrune, 1884, is without any doubt a female *S. inermis* (Férussac & d'Orbigny), but, as already indicated, the material mentioned by several authors from Japan, probably belongs to *S. japonica* (see Adam, 1944, p. 224). Hoyle's specimen is actually in poor condition and does not permit us to verify his statement that there are about ten rows of tentacular suckers, but the shell proves that it belongs to *S. japonica*.

The specimen identified with some doubt by Hoyle (1886, p. 137) as *Sepia recurvirostra* Steenstrup, 1875, consists of a fragment with a completely worn ventral surface, but the general outline and the dorsal surface leave little doubt that it belongs to *S. japonica*.

All Japanese references of *S. inermis* as indicated are probably records of *S. japonica*.

The latter is characterized by its large size (Sasaki 1929, p. 221, mentions a male specimen of 180 mm in mantle-length) by its regularly elongate-oval shell, without any sexual dimorphism, and by its tentacular club with at least 20 series of minute suckers.

IV. SYSTEMATIC CLASSIFICATION OF THE SEPIIDAE

During the last two hundred years a number of attempts have been made either to sub-divide the genus *Sepia* or to classify the different species in supra-generic categories.

The earliest and most simple classification was that of Linnaeus (1758) who classified all the known Cephalopoda in three genera: *Argonauta*, *Nautilus* (including the actual genera *Nautilus* and *Spirula*), and *Sepia*, embracing all the other Cephalopoda known to this author: *octopodia*, *officinalis*, *media*, *loligo* and *sepiola*; of these species, only *officinalis* is a *Sepia* as we understand it.

On the other hand, the most complex classification is that of Iredale (1954, p. 81) who grouped the Australian cuttlebones in three families, four sub-families and 13 genera. If this author had made a revision of the Sepiidae of other parts of the world, he certainly would have created some more families, sub-families and genera.

After Linné's simple classification, very little was added to the knowledge of Cephalopoda during the second half of the eighteenth century. In 1799, Lamarck (p. 4) restricted the generic name *Sepia* to the species with a calcareous cuttlebone, viz., *Sepia officinalis* and *S. tuberculata*. In the second edition of Lamarck's *Histoire naturelle des Animaux sans Vertèbres* (vol. XI, pp. 369–372), which appeared in 1845, only the same two species of *Sepia* are mentioned, although several other species had already been described. In fact, in the same yeard' Orbigny (pp. 261–298) listed 21 recent species of *Sepia*, most of which are still valid, as well as three species now of dubious value. He classified the species, the animal of which was known, according to the arrangement and the relative size of the suckers of the arms and tentacular club (pp. 264–265), thus:—

I. Sessile arms with equal suckers placed in four regular alternating lines.

1. Tentacular arms with unequal-sized cups placed in five or six lines—*S. bertheloti*, *S. hierredda*, *S. rouxii*, *S. savignyi*, *S. latimanus*, *S. officinalis*, *S. tuberculata*, *S. vermiculata*.

2. Tentacular arms with equal-sized cups placed in two[1] lines—*S. aculeata*, *S. blainvillei*, *S. inermis*, *S. ornata*, *S. rostrata*.

II. Sessile arms with unequal-sized cups not placed in four regular lines—*S. capensis*, *S. elegans*, *S. orbignyana*.

Gray (1849, p. 98) partly adopted d'Orbigny's classification of the Sepiidae in sub-dividing the genus *Sepia* into a number of sections based on the number of series of arm-suckers and of tentacular suckers and their relative size as well as on the characters of the shell. Those species of which the animal was unknown were placed in the different sections according to the resemblance of their shell. One of these sections was named *Sepiella*.

Gray's classification was as follows:—

I. Sessile arms with small equal cups placed in four regular alternating lines.
   1. Tentacular arms with unequal-sized cups placed in five or six lines—*S. officinalis*, *S. rouxii*, *S. vicellius*, *S. hierredda*, *S. latimanus*, *S. tuberculata*, *S. vermiculata*, *S. lefebrei*, *S. gibbosa*, *S. apama*.
   2. Cups of tentacular arms in five or six series, sub-equal, moderate-sized.
      a. Shell oblong: *S. lycidas*.
      b. Shell elongate, narrow: *S. bertheloti*, *S. plangon*.
   3. Tentacular arms with unequal-sized cups placed in 10 series—*S. savignii*.
   4. Tentacular arms finned, with numerous, small, equal-sized cups, placed in eight or 10 lines.
      a. Shell very narrow behind: *S. aculeata*, *S. rupellaria*, *S. elongata*, *S. sinope*.
      b. Shell oblong, posterior end expanded, produced, cartilaginous, not beaked, convex beneath—*Sepiella: S. ornata*, *S. sinensis*, *S. microcheirus*.
      c. Shell oblong, rounded behind, beaked: *S. rostrata*, *S. indica*, *S. myrsus*, *S. mestus*.

II. Sessile arms with equal, small cups. The upper pair with two rows of cups—*S. elegans*, *S. orbignyana*.

III. Sessile arms provided with very unequal-sized cups, the middle one largest. Shell narrowed behind—*S. capensis*.

With later knowledge of the Sepiidae we cannot entirely adopt these classifications which nevertheless have the merit of the first serious scientific approaches to the problem.

Steenstrup (1875, p. 468) created a new genus *Hemisepius* for a new species *H. typicus*, based on the characters of the animal and of the shell. In 1880 (p. 347) the same author redescribed Gray's section *Sepiella* as a separate genus and mentioned its morphological characters, especially the posterior gland and the characteristic locking-apparatus which differs from that of other Sepiidae in the cone-shaped tubercle and the corresponding depression. He also described the sexual difference in the shells of *Sepiella inermis*, but he was mistaken in considering Gray's *S. sinensis* as the male sex of *S. inermis*. In fact, the specimens which Gray called *S. sinensis* belong without any doubt to *S. japonica* Sasaki (see p. 128).

Rochebrune (1884, p. 74) proposed an entirely different classification of the Sepiidae, principally based on the characters of the shell and comprising ten genera: *Hemisepion*, *Diphtherosepion*, *Rhombosepion*, *Sepiella*, *Lophosepion*, *Spathidosepion*, *Doratosepion*, *Ascarosepion*, *Acanthosepion* and *Sepia*.

In his catalogue, Hoyle (1886, p. 230) commenting on this classification said, "most of these seem to me to be at most of subgeneric value, and there are so many points in which I find myself unable to follow Dr de Rochebrune that I have only given references to his paper in the case of his new

[1] The original text states "deux lignes", which is probably a printing error for "dix lignes".

species". Likewise, Sasaki (1929, p. 162) in his treatise on the Japanese Cephalopoda stated: "Some of them are grouped together into the genus *Doratosepion* by Berry. Although I adopted this view in one of my previous papers, here I am obliged to give it up, since the distinction of the sub-genus has become to me very vague with my own progress of the study on the subject."

In many respects we disagree with Rochebrune's classification and a few examples suffice to prove its fallacy. The author mentions as first species of his genus *Diphtherosepion: S. ornata* which is a *Sepiella*. In his genus *Rhombosepion* he enumerates *S. touranense* which is a synonym of *Sepiella inermis*. In *Sepiella* he places *S. lycidas* which is not a *Sepiella* at all but a species of the *Sepia aculeata* group. In *Lophosepion* he places *S. apama*, the animal and shell of which are completely different from the two other species (*S. lefebrei* and *S. gibbosa*) for which the genus was created. He considers *S. fischeri* as an *Ascarosepion*, whereas this species is in fact only a form (or sub-species) of *S. officinalis*. Among the many species of *Acanthosepion* he mentions *S. rappiana* which is a synonym of *S. latimanus* which he enumerates under *Sepia*, and *S. hierredda* and *S. vermiculata* which are sub-species of *Sepia officinalis*. Finally he mentions *S. myrsus* under *Sepia*, whereas this shell, which seems to belong to *S. simoniana*, most resembles that of a *Spathidosepion*.

Hoyle (1885, p. 199) has created a sub-genus *Metasepia* for *S. pfefferi* because of its peculiar shell.

For nearly 40 years no new attempts were made to classify the Sepiidae.

In 1923, Naef published his monograph on the Mediterranean Cephalopoda with an extensive study on the morphology and the phylogeny of the group.

He proposed to classify the Sepiidae (pp. 543 and 545) in three genera: *Sepiella*, *Hemisepius* and *Sepia*, and divided the latter genus in seven sub-genera: *Eusepia* (type: *S. officinalis*), *Parasepia* (type: *S. orbignyana*), *Acanthosepia* (type: *S. aculeata*), *Doratosepia* (type: *S. andreana*), *Platysepia* (type: *S. esculenta*), *Lophosepia* (type: *S. lefebrei*) and *Metasepia* (type: *S. pfefferi*).

This classification was based on the morphological characters of the animal and the shell. As many species had been insufficiently described, the author was unable to revise all the Sepiidae, but in his opinion (p. 542) a natural system would result easily if the main characters of the animal and of the shell of each species were described.

Unfortunately, Iredale neglected this sound advice when he began the description of the Australian Sepiidae in 1926. Although he stated (1926, p. 188): "I have examined animals of half of the species represented in the Australian Fauna, and propose to describe them in my larger essay," he never described a single animal and his numerous new species and genera were only based on the shells. In 1954 (p. 63) he mentioned that "Animals are still being acquired with the hope of providing some stable means of determination, but at the present the bones are the only sure means of differentiation". In this paper the author presents the following check list of the Australian Sepiidae (p. 81):—

Family Sepiidae
  Sub-family Solitosepiinae
    Genera: *Solitosepia*, *Blandosepia*, *Mesembrisepia*, *Amplisepia*, *Decorisepia*, *Glyptosepia*.
  Sub-family Doratosepiontinae
    Genus: *Arctosepia*.
  Sub-family Tenuisepiinae
    Genus: *Tenuisepia*.
  Sub-family Acanthosepiontinae
    Genera: *Acanthosepion*, *Crumenasepia*, *Ponderisepia*.

Family Sepiellidae
    Genus: *Sepiella*.

Family Metasepiidae
    Genus: *Metasepia*.

In the foregoing descriptive part we have expressed our opinion sufficiently on the numerous species and genera created by Iredale, whose concepts of systematic categories seem to differ so considerably from ours. Most of the species of his genera are in our opinion only individual, sexual or geographical variations of a same species; some of his genera and even sub-families or families have only generic or probably sub-generic or specific value. His genus *Arctosepia*, for example, was created (1926, p. 193) "In order to enable correct study of the Australian animals to be undertaken"; the descriptions of the different species of this genus(?) do not reveal a single generic character which permits to separate it from Rochebrune's genus *Doratosepion*. In his genus *Solitosepia* he (1954, p. 66) considers *submestus*, *lana*, *galei* and *papuensis* as species in the super-species or group of *papuensis*; in our opinion this super-species is only a species.

In 1939, Adam revised the Indo-Malayan species of *Sepia* and all the species of *Sepiella*. For the former genus he concluded that the shell and the tentacular club presented the best characters for distinguishing the species but that our knowledge of this genus was not yet sufficient to establish the phylogenetic relations between the different species and hence to arrive at a satisfactory systematic classification.

Such a classification should be based on the characters of the animal and the shell of the recent species and on their relationship with the fossil species of which only the shell is known. As we mentioned on p. 132, Naef (1923, p. 542) was very optimistic about the results of such a study, perhaps because he had only examined a few species. Unfortunately it often happens that the more species that are studied, the more difficult a classification becomes. In fact, if we had a thorough knowledge of all the fossil and recent species which have existed and exist it would probably be difficult to recognize any species at all. We should be able to study evolution as we study embryological development, but unless evolution had proceeded by sudden important mutations, a sub-division into systematic categories would be purely arbitrary.

In the descriptive part of our paper we have revised all the recent species of Sepiidae. If we exclude the species which, in our opinion, can be placed in synonymy, there remain about 108 species (see p. 145), some of which may also have to disappear. Of less than half of these species (53) both sexes of the animal have been described and their shell is generally sufficiently known. Thirteen species are known only from the male animal and its shell, a dozen only from the female animal and its shell, four are insufficiently described and of 30 species only the shell is known; among the latter, 28 are Australian species, more than half of which will probably have to be placed in synonymy.

According to Hoyle (1886, p. 148) "the problem of the natural relationship of the various species of *Sepia* is far from having been satisfactorily worked out. The shells, which seem in many respects the organs most likely to lead to a solution, can be arranged in series increasing or decreasing in complexity, and there are several interesting fossil genera, which help to bridge over the gulf separating *Sepia* from the Belemnites, but an arrangement of the species based upon the shells does not agree with one based upon the form of the tentacular club, or other parts of the animal's organization, so that we are hardly justified in regarding it as natural".

If we wish to arrive at a natural classification we have to establish the connexion between the recent and the fossil forms. Unfortunately the latter are only known by their shells, which have been found exclusively in European tertiary layers, whereas the majority of the recent species inhabit other parts of the world. We have no certainty at all that these recent species are the descendants of the European fossil species, we do not even know if they have a monophyletic or a polyphyletic origin.

The Miocene and Pliocene species which seem to belong to the genus *Sepia* do not show enough details to allow a comparison with the recent species. According to Naef (1922, p. 92) some of them show a faint indication of the remains of the pro-ostracum as in some recent species of the *aculeata*-type. These Miocene forms seem to be the descendants of the Eocene *Belosepia*.

This genus which was created by Voltz (1830, p. 410) for *Beloptera sepioidea* Blainville, 1825, has

been described and figured in detail by Edwards (1849, pp. 23–25, pl. I) in his monograph of the Eocene mollusca. Generally only the posterior part of the shells of *Belosepia* is preserved; they show great resemblance to the recent cuttlebones although the septa of the phragmocones are always lacking and represented only by small fragments near the end of the funnel-shaped posterior portion of the conotheca. At first sight this conotheca seems to differ a great deal from the inner cone of the recent cuttlebones which is fork-shaped. In his detailed description of the shell of *Sepia*, Appellöf (1893, p. 6) states that the lateral limbs of this fork ("Gabel") are in close contact with the septa of the phragmocone and in his figures (pl. I, fig. 4, pl. II, fig. 3) they seem to be separated without a connexion on the dorsal side of the phragmocone, which seems to be fused immediately to the inner plate of the dorsal shield. But when we dissolve a cuttlebone in acid it becomes clear, as Naef (1923, p. 522) has already observed, that the conotheca separates the whole phragmocone from the dorsal shield as a very thin chitinous membrane and that the inner cone is really homologous with the ventral part of the conotheca of *Belosepia*. If we assume that *Belosepia* is the ancestor of the recent Sepiidae, we can admit that those forms which have the ventral part of the inner cone still well developed are primitive.

The striated area of the phragmocone which seems to represent the siphuncle of *Belosepia* does not seem to be of much systematic value.

Denton & Gilpin-Brown (1961, p. 319) have shown that cuttlefish use their shell "as a variable buoyancy tank" and "that liquid is probably moved in and out of the cuttle-bone by an osmotic mechanism". In fact, "the chambers of the cuttlebone contain liquid as well as gas, and the cuttlefish changes its density and posture by varying the amounts of liquid which the chambers of the bone contain". Their experiments (pp. 333–335) show that liquid exchange can occur across the striated area, which they call the "siphuncular surface", the latter being covered by a specialized membrane in which, through a special drainage system, liquid from the circulation comes into close communication with the liquid within the cuttlebone. The authors (pp. 335–336) examined the bones from different species of *Sepia* and found "that they differed appreciably in the ratio of siphuncular surface area to the total surface area of the cuttle-bone" and that they " expect that the species with cuttlebones with relatively large siphuncular surfaces are those which can change their density most quickly". They made their experiments with *Sepia officinalis* from the trawling grounds off Plymouth, mostly in depths between 25 and 40 fms.; unfortunately we are not told which sub-species (*officinalis* or *filliouxi*). In answer to our enquiry about this question, Dr Denton replied that in his opinion these forms belong to the same species. This we do not contest, but in the light of their results it may be very important to know if these bones belonged to *filliouxi*, with its long striated area, or to *officinalis* which has a much shorter siphuncular surface.

In fact, the sub-species *filliouxi* seems to be the only one which migrates in the spring into the North Sea to spawn. As its large siphuncular surface permits quick changes of its density and hence quick adaptation to environments of different density, this character may be closely related to the migratory habits of this form.

On the other hand, the capacity of the air and liquid chambers of the phragmocone must be certainly related to the density of the environment and to the possibility for the animal to adapt itself to different environmental conditions. The convexity and the width of the phragmocone give us an idea about the total capacity of the chambers.

In this connexion it is perhaps worthwhile to note that the species with the relative highest phragmocone: *Sepia gibba*, *S. dollfusi* and *S. elongata*, live in the northern part of the Red Sea, in waters of very high salinity (about 40‰ in the Gulf of Eylath; see Oren, 1960, p. 12). Unfortunately we know very little about these species of which only a few animals have been collected in shallow waters and we do not know their exact bathymetrical distribution and their eventual migratory habits. In these waters it is of course very easy to float, but diving in deeper waters demands either an important

energetic effort or the capacity for the animal to greatly increase its density. Under these conditions the larger volume of the phragmocone is certainly a very favourable asset.

The third character of the shell which we have to discuss is the presence or absence of a posterior spine. In *Belosepia* this spine is always present and very strong. In recent *Sepiidae* the spine is more or less developed in a great number of species, but may be reduced or even be completely absent. According to d'Orbigny (1845, pp. 139) and Edwards (1849, pp. 15–16), this spine breaks the force of the shocks caused by the body striking against any hard substance in its backward movement. The former author states that he has always observed in *Sepia* that the extremity of the spine projects beyond the body and that it is not improbable that this part of the shell may be used for defensive purposes and can be protruded at the will of the animal!

According to Abel (1916, pp. 160–161) the spine of *Belosepia* is not homologous with the rostrum of the Belemnites. He does not consider it as a rudimentary formation and thinks that it functioned as a plough through the marine vegetation or the soft mud. In his opinion the spine of *Sepia* is certainly homologous with that of *Belosepia* (p. 162). He states that the fact that the spine of *Sepia officinalis* increases during its whole life in length, volume and strength and only pierces the mantle at an advanced age at which it often becomes worn when the animal digs itself in in the mud or ploughs through the forests of algae or the meadows of *Zostera*. He asserts that this spine is not at all a functionless, rudimentary organ, but a developing, orimentary formation!

All these statements are rather fantastic. In well preserved specimens we have never seen that the spine pierces the mantle; this may occur through contraction of the mantle during fixation or in macerated specimens. It is difficult to imagine that the spine of recent Sepiidae which is generally delicate could break the shock when the animal strikes against any hard substance in its backward movement; at the first shock it would probably break off. Its use for defensive purposes is still more fanciful. As it is generally directed straight backwards or towards the dorsal side we do not understand how the animal could use it as a plough. In *Sepia officinalis hierredda* and *S. officinalis vermiculata* it remains free of chitin in all growth stages, but in the other sub-species it becomes more and more covered by the chitinous posterior hood and never pierces the mantle.

If the spine of recent Sepiidae has any function at all it is probably only that of a solid support which determines the torpedo-like shape of the mantle, useful in backward movement.

As all the authors agree that the spines of *Belosepia* and of *Sepia* are homologous, we presume as already indicated, that the presence of a well-developed spine in recent species can be regarded as a primitive character. As to the presence of a ventral or a dorsal or of two keels on the spine, we do not know whether they have any significance.

The interpretation of the characters of the animals is much more difficult because no fossil remains are known.

Naef (1915, fig. 255; 1922, p. 45, fig. 11; 1923, p. 479, 488, fig. 260) has reconstructed a hypothetical prototype of the Sepioidea, which he named *Protosepioides*. The only characters of this prototype which we wish to retain as a possible basis for the discussion that follows are: 1. the arrangement of the arm-suckers of equal size in four longitudinal series; 2. the arrangement of the tentacular suckers of uniform size in eight longitudinal series in the middle of the club, and the protective membranes separated at its base; 3. the presence of small suckers at the tips of the buccal membrane.

Most of the recent species have their sessile arms covered with suckers in four series, but in some this arrangement is partially or totally replaced by a biserial one. In many species the suckers of the male are more globular than in the female. The denticulation of the chitinous ring of the arm-suckers generally cannot be used for systematic purposes, in most species the ring is irregularly incised in young specimens but is sometimes smooth in old ones.

The length of the arms is subject to great variations depending on the state of conservation. In some species certain arms of the males are much longer than the other ones, for example the dorsal

arms of *Sepia pardalis*, *S. incerta*, *S. lorigera*, *S. longipes*, *S. tenuipes*, the dorso-lateral arms of *S. andreana* and *S. peterseni*, the dorsal and ventral arms of *S. erostrata*. Moreover these longer arms may present other modifications like the membraneous expansions of the dorsal arms of *S. incerta* and *S. exsignata* (the latter being probably the male of *S. burnupi*).

With a few exceptions (*S. latimanus* and *S. papuensis*) the males of all the species have their left ventral arms modified. This hectocotylization consists of a reduction of the size of some of the transverse rows of suckers and may affect the basal, middle, or distal part of the arm. This modified portion often shows strong fleshy transverse ridges and wider protective membranes. Exceptionally, the suckers of the right ventral arm show a sexual dimorphism, as in *S. elobyana*, where certain suckers have their chitinous rings strongly developed. In the species of *Sepiella*, the arm-suckers show a distinct sexual dimorphism in the dentition of the chitinous ring, the distal part of which is armed with strong, pointed teeth in the males.

In *Hemisepius typicus*, *Sepia hieronis* and *S. robsoni* some of the arm-suckers of the males or of both sexes are larger than the other ones. This character is an unusual one in the Sepiidae but common in the Sepiolidae.

A very peculiar secondary sexual character is present in the males of *S. confusa* where the fins are prolonged at their posterior end in a long tail-like formation.

The tentacles of the Sepiidae differ in two essential points from those of the other decapod Cephalopoda. They can be completely retracted in a special pocket and be suddenly projected for the capture of a prey. On the other hand the tentacular club differs: *a*, in the approach of the swimming-membrane to the dorsal protective membrane and the development of a deep cleft between these two membranes; *b*, in the enlargement and thickening of the ventral protective membrane which becomes partially part of the sucker-bearing surface. In most species the protective membranes remain separated at the base of the club, but in some they become fused so that the sucker-bearing surface is completely separated from the tentacular stem. This character is particularly evident in *S. latimanus*, *S. apama* and *S. bandensis* and in a lesser degree in *S. tuberculata*, *S. papillata*[1], *S. papuensis*, *S. elliptica* and *S. plangon*.

In most species the arrangement of the tentacular suckers is in eight longitudinal series. This is best seen in species with sub-equal suckers, but in those with unequal suckers the transverse rows become more and more oblique and the number of longitudinal series seems to be reduced. In fact the original arrangement of eight series can nearly always be retraced.

In a few species with very small equal suckers these are arranged in more than eight series, with a maximum of about 24, or even more, in *Sepiella japonica*. This increase in the number of series of suckers may differ in the males and females of a same species, the latter having more series than the former, as in *S. aculeata* and *Sepiella ornata*. Generally the tentacular club presents very distinct specific characters although there may be some variation in the size of the suckers.

Probably the arrangement in eight series of equal suckers is the primitive one from which the other forms are derived. As the function of the tentacles is the capture of prey, it would be very interesting to study the structure of the tentacular club and the size and number of its suckers in relation to the sort of prey which is captured.

The buccal membrane of some species possess a few minute suckers at its tips. Unfortunately these very tiny suckers are easily overlooked or lost. Their presence probably constitutes a primitive character.

In most species the ventral part of the buccal membrane of the females is largely expanded and wrinkled and functions as a depository for the spermatophores (Tompsett, 1939, p. 20 calls it a "burs copulatrix").

[1] According to Voss (1962*b*, p. 251) the protective membranes do not unite proximally.

In some species this ventral part of the buccal membrane contains one or two spermathecae. In well preserved specimens the openings of these formations are easily seen as nipple-like structures, otherwise they are only detected after dissection. The material we had at our disposal did not allow a detailed study of this character.

In *Sepia officinalis*, *S. bertheloti* and *Sepiella ornata* there is one pair of spermathecae, whereas *S. elegans* and *S. orbignyana* possess a single median one.

The internal anatomy of most species has never been described and the specimens we examined did not permit a detailed study. Therefore a classification of the Sepiidae can for the moment only be based on the external morphological characters and on those of the shell.

If we consider the strong development of the ventral part of the inner cone, the presence of a posterior spine and of sub-equal tentacular suckers as primitive characters, the following species seem to be more or less related: *S. thurstoui*, *S. brevimana*, *S. zanzibarica*, *S. lycidas*, *S. savignyi*, *S. aculeata*, *S. elliptica*, *S. whitleyana*, *S. esculenta*, *S. smithi* and *S. pageora*.

Among these species, *S. thurstoni*, *S. brevimana*, *S. zanzibarica* and *S. lycidas* have eight series of sub-equal tentacular suckers; in *S. zanzibarica* these are less equal than in the other ones and in *S. brevimana* the seriation is less distinct. *S. savignyi* may be added because of its tentacular suckers, but the posterior part of the inner cone is less developed. These five species have a well developed median groove on the ventral part of the shell. As for the lateral limbs of the inner cone, these are widest in *S. thurstoni*, *S. brevimana* and *S. savignyi*, they are somewhat narrower in *S. zanzibarica* and still more so in *S. lycidas*. In *S. savignyi* the marginal parts of the lateral limbs are shiny and flattened.

In *S. aculeata*, *S. elliptica* (which is probably identical with *S. whitleyana*) and *S. esculenta*, the inner cone is also strongly developed, but the tentacular club has about 12 series of sub-equal suckers.

As regards the inner cone, *S. aculeata* more closely resembles *S. thurstoui*, but the ventral surface of the phragmocone is convex. *S. elliptica* and *S. esculenta* possess the well developed ventral groove of the first group but the posterior part of the inner cone is different from most of them, consisting of a flat ledge with a thickened anterior margin, as in the female of *S. brevimana*. At the end of this evolutionary (?) series we have *S. smithi* and *S. pageora* which are perhaps conspecific. Their shells more closely resemble those of the first group, especially *S. thurstoui* and *S. brevimana*, because of the wide smooth zones between the striated area and the outer cone. Their tentacular clubs have very numerous tentacular suckers, arranged in about 20 longitudinal series.

All these species have quadriserial arm-suckers and some of them possess a few buccal suckers: *S. zanzibarica*, *S. lycidas*, *S. savignyi* and *S. aculeata*.

The males of nearly all these species have the modified portion of the hectocotylus situated on the basal half of the left ventral arm; this is preceded proximally by a few transverse rows of normal suckers. Only *S. zanzibarica* seems to be different and has the hectocotylus situated on the distal third of this arm according to Massy (1925, p. 211). We wonder if this statement is correct as this author mentions six transformed rows of suckers, "arranged so as to leave a bare flattened surface with ridges bordered by a single row of suckers ventrally, while those of the dorsal side are crowded together". It is difficult to imagine that six rows of distal suckers, which are generally minute, would occupy a third of the arm.

Several species of this first group have been described as belonging to the genus or sub-genus *Acanthosepion*. For *S. esculenta*, Naef (1923, p. 546) created a sub-genus *Platysepia*, whereas Iredale (1926*a*, p. 239) established a sub-genus *Fiscisepia* of *Acanthosepion* for *S. elliptica*. As the shells of both these species do not show any sub-generic and even hardly specific differences, we consider *Fiscisepia* as synonymous with *Platysepia*. If this sub-genus is based on the characters of the shell, the female of *S. brevimana* ought to be placed in *Platysepia* and the male in *Acanthosepion*. If the number of series of tentacular suckers is taken as a base for sub-division, we can distinguish those

with eight series, with 12 to 14 and with about 20 series. In that case *S. aculeata* and *S. esculenta* belong to the same group but their shells would belong to different sub-genera. We could work out a classification based on several characters, but finally nearly every sub-genus or section would only contain a single species and in the case of *S. brevimana* the males and females would have to be placed in different categories, which proves the fallacy of such a system.

Two other species, *S. pharaonis* and *S. prashadi*, possess a well developed ventral part of the inner cone but have unequal tentacular suckers. In *S. pharaonis*, the posterior part of the inner cone forms a long, flat ledge, applied to the striated area, and the third and fourth tentacular suckers of the transverse rows are distinctly wider than the other ones. The buccal membrane bears some minute suckers and the hectocotylus is situated more in the middle of the arm than in the foregoing species, there being twelve rows of normal suckers at the base, followed by ten rows of modified suckers. Forms of this species have been placed by different authors in three different genera or sub-genera: *Acanthosepion*, *Ascarosepion* and *Crumenasepia*. The peculiar form of the inner cone is certainly very characteristic, but we consider it only of specific value. In fact, in our opinion all the species described as possessing this peculiar inner cone which would justify their classification in the genus or sub-genus *Crumenasepia*, belong to a single species: *S. pharaonis*.

As for *S. prashadi*, the ventral part of the inner cone is more like that of *S. aculeata*, but the spine is keeled on the ventral and dorsal sides. The tentacular suckers are very unequal, those of the third series being enormously developed. The transformed part of the hectocotylus is situated at the base of the arm, where two rows of normal suckers are followed by a dozen rows of modified ones.

Although the above-mentioned 13 species have several characters in common, there are different tendencies in the development of the tentacular club: either the suckers remain sub-equal and their number of longitudinal series increases, or the original arrangement of eight series remains and the suckers become unequal, only slightly in *S. zanzibarica*, but very strongly in *S. prashadi*. But if the presence of keels on the spine constitutes an important character, which we do not know, it may be that this latter species belongs to another group.

In a second group, or probably several groups of species, the inner cone is still well developed, with wide limbs, but it is completely reflected on to and fused with the outer cone. Among these species we can distinguish those that possess a well developed posterior spine, which may become covered by a chitinous hood in the adult shells, and those that are completely devoid of a spine and which we discuss separately on p. 142.

All these spined species have unequal tentacular suckers, generally arranged in eight longitudinal series, although this arrangement is not always easily detected.

An intermediate form between the species with a free posterior part of the inner cone and those with a completely fused inner cone, is *S. recurvirostra*, where the posterior portion of the inner cone forms a thin, free ledge which is connected with the outer cone by a thick callous substance. *S. recurvirostra* has unequal tentacular suckers, which seem to be arranged in five or six series, it may possess some buccal suckers, and the shell has a spine without keels.

Among the spined forms with completely fused inner cone, *S. officinalis*, with its sub-species, has the tentacular suckers very unequal, those of the third series being largest. The protective membranes of the tentacular club remain separated at the base. In the two southern sub-species, *hierredda* and *vermiculata*, the spine is always uncovered, but in the northern ones, *officinalis* and *filliouxi* it becomes more and more covered by the chitinous hood in the adult shells. The hectocotylus has about three groups of four normal suckers at its base, followed by eight to 13 transformed rows in *hierredda* and *vermiculata*, but only five to seven in *officinalis* and *filliouxi*.

Although *S. officinalis* is the type of the genus *Sepia*, its sub-species have been mentioned by several authors as belonging to different sub-genera or genera: *Acanthosepion*, *Ascarosepion* and *Eusepia*.

The shell of *S. latimanus* differs from that of *S. officinalis* in its much stronger posterior spine.

The tentacular club of the former species is completely different, the protective membranes being fused at the base and the sucker-bearing surface detached from the stem.

Exactly the same kind of tentacular club is found in *S. apama*, but the shell of the latter is completely different, its posterior end being drawn out in the adult, the spine generally completely covered and the inner cone fused and equally drawn out. In a medium-sized shell, this peculiar transformation of the posterior part does not yet exist, but already at this size it has the callous-like formation situated in the inner angle of the inner cone. The shells of very young specimens are very interesting, strongly resembling those of *S. bandensis*, except that the latter has no spine. The animals of *S. baudensis* and the young *S. apama* are completely similar and cannot be distinguished externally. If the tentacular club has any systematic importance, *S. baudensis* is most closely related to *S. latimanus* and *S. apama*, but the shell of *S. baudensis* more resembles those species which Iredale placed in his genus *Blandosepia* (the animals of which are unknown), and still more that of *S. tuberculata* from which it can hardly be distinguished. In the latter species the protective membranes of the tentacular club are also fused at the base, but the sucker-bearing surface is not detached from the stem.

It is noteworthy that the male of *S. latimanus* does not show any trace of hectocotylization of its left ventral arm, whereas in *S. apama* this arm is normally hectocotylized with eight rows of normal suckers at its base, followed by eight rows of transformed suckers.

Sepia latimanus has been placed in *Acanthosepion* by some authors, but Iredale (1926*a*, p. 239) has created for it a new genus *Ponderisepia*. For *S. apama*, this author created (1926, p. 194) a new genus *Amplisepia*, which Thiele (1934, p. 954) considered as a synonym of *Ascarosepion*, but his opinion was based on the erroneous interpretation by Iredale of *Ascarosepion verreauxi* Rochebrune (see p. 47).

Sepia papuensis retains the broad limbs of the inner cone and the posterior part of the fused inner and outer cone forms a chitinous ledge surrounding the posterior depression, but the spine is keeled ventrally. The protective membranes of the tentacular club are fused at the base, but the sucker-bearing surface is not detached from the stem as in *S. latimanus* and *S. apama*. As in *S. latimanus*, the male of *S. papuensis* does not show any trace of hectocotylization. Iredale (1954, p. 66) considers *S. papuensis* as a super-species or group of his genus *Solitosepia* and admitted *submestus*, *lana*, *galei* (= *occidua*) and *papuensis* as species in this super-species (see p. 40).

Sepia plangon seems to be closely related to the foregoing species, the tentacular club is the same, but the shell differs in the narrower limbs of the inner cone and in the deep, narrow, median groove. The left ventral arm of the male is hectocotylized with five rows of normal suckers at its base, followed by five rows of transformed suckers.

Like the two foregoing species, *S. mestus* has a ventrally keeled spine, but the inner cone has broader limbs. The animal of this species is unknown, unless the specimen from N. China (p. 45) really belongs to this species.

These three species which have a ventrally keeled spine were placed by Iredale in his genus *Solitosepia* (1926, p. 188), which is synonymous with *Ascarosepion* Rochebrune.

A further species with a well-developed inner cone is *S. novaehollandiae*. The limbs of its inner cone are slightly narrower than in *S. mestus* and the spine has no keels. The animal is not known with certainty. For this and some similar species(?), Iredale (1926, p. 191) created a new genus *Mesembrisepia*.

In the first group of species with characters which we supposed to be primitive, there seems to be a certain relationship between the different species. But in the second, in which the ventral part of the inner cone is reduced, although still well developed, and fused with the outer cone, most species show very little relationship among each other and these seven species have been classified by different authors in a great number of sub-genera or genera: *Sepia*, *Acanthosepion*, *Ascarosepion*, *Ponderisepia*, *Amplisepia*, *Solitosepia* and *Mesembrisepia*.

All the other spined species have a still more reduced inner cone with narrow limbs. The tentacular suckers are nearly always arranged in eight longitudinal series. Sometimes there are apparently fewer series, but in most of these cases the suckers are undoubtedly arranged in oblique transverse rows of eight.

In nearly all the species of this third group, the outer cone has two posterior wings, which form, in the narrower shells, a typical cup-like expansion. As to the spine, it is generally devoid of keels but may sometimes be keeled, dorsally, ventrally or on both sides.

In a first sub-group the outer cone shows no wings or cup. *Sepia acuminata* has a rather broad shell with a keel-less spine. The minute, sub-equal, tentacular suckers are arranged in eight to ten series. The hectocotylus has six rows of normal suckers at its base, followed by nine rows of transformed suckers. This species seems to be closely related to the Japanese *S. madokai* (p. 56) and to the Australian *S. rex* (p. 56). *S. jaenschi*, which is probably identical with *S. rex* has a similar shell, but the animal is unknown.

Sepia bertheloti has a much more elongate shell, a keel-less spine and slightly unequal tentacular suckers, arranged in eight series. Its hectocotylus has a few normal suckers at the base, followed by nine to 13 rows of transformed suckers. The animals of this species are not easily distinguished from *S. officinalis*, but the ventral arms of the male are relatively much longer and the largest tentacular suckers smaller.

Sepia cultrata has a dorsal and a ventral keel on its spine; the small, sub-equal tentacular suckers seem to be arranged in five series. The male of this species is unknown.

The species of this sub-group have been classified in different sub-genera or genera: *S. bertheloti* in *Acanthosepion*, *S. acuminata* in *Rhombosepion*, *S. rex* and *S. jaenschi* in *Decorisepia*, and *S. cultrata* in *Glyptosepia*. The latter genus was created by Iredale (1926, p. 191) for shells characterized by the loss of the inner cone, but there does not exist a single species of Sepiidae without an inner cone!

In a second sub-group, the shell possesses a posterior cup-like expansion and keel-less spine whereas the tentacular club has sub-equal suckers.

Sepia appellöfi and *S. tenuipes* have eight series of minute, sub-equal tentacular suckers. In *S. sewelli* this arrangement is less distinct, the sucker-bearing surface being narrower. In *S. murrayi* this is still more pronounced and there seem to be only five series of tentacular suckers. With the reduction of the sucker-bearing surface, the width of the free portion of the dorsal protective membrane becomes more important. Of these four species only the males of *S. appellöfi* and *S. tenuipes* are known, that of the former has 12 rows of normal suckers at the base of the hectocotylus, whereas the distal third of the arm is transformed; that of the latter has seven or eight rows of normal suckers at the base and the distal half is transformed.

Moreover, the male of *S. tenuipes* has its dorsal arms twice as long as the others.

In a third sub-group the shell also possesses a posterior cup-like expansion and a keel-less spine, but the tentacular suckers are unequal. In some species the ventral part of the inner cone forms a short, rounded ledge.

In *S. confusa* the tentacular club is well developed with rather numerous suckers, that are distinctly unequal in size, but less so than in the following species. The male of *S. confusa* does not show any hectocotylization of its ventral arms, but has an unique tail-like formation of the fins. The shell of *S. confusa* resembles that of *S. pardalis*, but this Japanese species lacks the peculiar tail and has a distinct hectocotylus with about 17 rows of normal suckers proximally and the distal third of the arm is transformed; here the minute sub-equal tentacular suckers are arranged in eight series, as in *S. appellöfi*.

In *S. incerta*, the median tentacular suckers are relatively much bigger than in *S. confusa*. The male of this species possesses not only a hectocotylus with the distal half of the arm transformed, but also a very peculiar transformation of the dorsal arms. *S. lorigera* seems to be very closely related to *S.*

incerta in the characters of the shell and of the animal. *S. longipes* is also very similar but has both ventral arms of the male hectocotylized.

Sepia joubini has a similar tentacular club, but the shell of this small species is imperfectly known; the original description stated it to be of the *Doratosepion* type with a spine. The female of this species has very narrow lateral arms that are whip-like in their distal halves, and are armed with minute biserial suckers. The hectocotylization of the left ventral arm of the male is little pronounced, six rows of suckers on the distal half of the arm being modified.

In *S. kobiensis*, the sucker-bearing portion of the tentacular club is relatively narrower and the free margin of the dorsal protective membrane is wider. The hectocotylus has about 12 rows of normal suckers at its base, whereas the greater part of the distal half of the arm is transformed. The ventral part of the inner cone forms a more or less developed posterior ledge.

The shell of *S. andreana* resembles that of *S. kobiensis*, but the animal is different, the dorso-lateral arms of the male being about three times as long as the others. The hectocotylus is transformed in its distal half.

Sepia peterseni is also a closely related species with very long dorso-lateral arms in the male and a similar hectocotylus, but it seems to be an inhabitant of temperate waters, whereas *S. andreana* is a cold water species.

Sepia tokioensis, which does not seem to differ essentially from *S. misakiensis*, has the hectocotylus only slightly transformed in its distal part. The fins are thickened and expanded into lobes at their posterior end.

The shell of *S. kiensis* is relatively broader and flatter than that of *S. kobiensis* and recalls that of *Arctosepia rhoda*. Only the female of *S. kiensis* is known.

Sepia braggi, the animal of which has not been described, has a very slender shell which recalls the shells of *S. burnupi* and *S. trygonina*. The latter are so much alike that they can easily be confused; both have the lateral limbs of the inner cone much closer together than in any other species, but the mid-dorsal rib of *S. burnupi* is more distinct than in *S. trygonina*. The hectocotylus of *S. burnupi* is unknown, but we presume that *S. exsignata* is synonymous with *S. burnupi*. *S. exsignata* has both ventral arms hectocotylized in their distal half with a reduction of the size of the suckers and with some cirri at their tips. Moreover the dorsal arms of the male are modified, the outer protective membranes possessing long, cirriform processes, the inner ones have shorter points. *S. trygonina* has no modification of the dorsal arms and only the left ventral arm is hectocotylized in its distal half.

Sepia elongata has a similar tentacular club and hectocotylus to *S. trygonina*, but the shell is distinctly different, the ventral surface being much higher and the limbs of the inner cone wider apart.

Many species of this third sub-group have been placed by different authors in the genus or sub-genus *Doratosepion*, but for the Australian species, the animals of which are unknown, Iredale (1926, p. 193) has created a new genus *Arctosepia*, which cannot be distinguished morphologically from *Doratosepion*. Those of the second sub-group have a similar shell, but sub-equal tentacular suckers.

In a fourth sub-group of the species with posterior wings at the outer cone, the spine is keeled.

Sepia orbignyana has a ventral keel on the spine and unequal tentacular suckers. The hectocotylus is transformed in its basal two-thirds. The female has only a single spermatheca.

Sepia australis possesses a dorsal keel on the spine which continues on the posterior part of the dorsal surface of the shell. The animal has very unequal tentacular suckers and the hectocotylus is transformed on more than its basal half, which bears two pairs of normal suckers, followed by 13 slightly alternate pairs of smaller ones.

The shell of *S. sulcata* resembles that of *S. australis*, but the tentacular club bears eight series of minute, sub-equal suckers. The hectocotylus is transformed in its basal three-fourths.

Sepia omani has a dorsal and a ventral keel on its spine and very unequal tentacular suckers. The hectocotylus has two groups of four normal suckers at its base, followed by about ten rows of trans-

formed suckers which cover two-fifths of the arm-length.

Finally there are three species in which the cuttlebone has posterior wings at the outer cone but is without a spine. Among these, *S. erostrata* has a rounded eminence at the posterior end of the shell, whereas *S. elegans* and *S. arabica* possess a dorsal keel as in *S. australis*. *S. arabica* has sub-equal tentacular suckers, but in *S. elegans* and *S. erostrata* they are very unequal. In the male of *S. erostrata* the only indication of a hectocotylization is a diminution in size of the suckers of the middle part of the left ventral arm. Moreover, the dorsal and ventral arms of the male are longer than the lateral ones. The male of *S. elegans* has a few normal suckers at the base of the hectocotylus which is modified on two-thirds of its length. In *S. arabica* the sucker-bearing surface of the left ventral arm of the male is folded together and nearly completely covered by the protective membranes; the right ventral arm shows the same phenomenon to some degree.

As in *S. orbignyana*, the female of *S. elegans* possesses a single spermatheca. For these two species, Naef (1923, p. 545) created a sub-genus *Parasepia*. In fact, these species have many characters in common, but they differ in the absence of the spine in *S. elegans*. For the latter species, Rochebrune (1884, p. 82) had already created the genus *Rhombosepion*.

If we reconsider all the species in which the shell has posterior wings or a cup-like posterior expansion, we see again several tendencies in the development of different characters. In all the species the inner cone has narrow limbs, but sometimes the posterior ventral part forms a small ledge surrounding a small depression; this feature can be considered a primitive character. Most of the species have a spine which may be keeled, but in some it is lacking. In the majority of these species, the hectocotylus is transformed in its distal part, but sometimes in its basal portion. In several species the arm-suckers are partly biserial, either at the base or at the distal part of the arms. As this character is sometimes rather obscure and may be differently developed in the males and the females of a same species we have not discussed it in detail. The tentacular suckers are sub-equal or more or less unequal, but they are never arranged in more than eight series.

All the other species are without spines and are quite different, possessing relatively broad shells with a more or less developed inner cone and without posterior wings at the outer cone.

Sepia dollfusi and *S. gibba* have the phragmocone strongly swollen and the broad lateral limbs of the inner cone are fused to the outer cone. The tentacular suckers are slightly unequal and arranged in eight series.

In *S. dollfusi* the buccal membrane may have a few minute suckers. The hectocotylus of both species has a few rows of normal suckers at the base, followed by about eight series of transformed suckers.

Sepia elobyana is a rather puzzling species (see p. 104): the type-specimen having very unequal tentacular suckers, whereas the other specimens have them sub-equal. The left ventral arm of the male is hectocotylized in its basal half, and the right ventral arm shows a very peculiar transformation of the chitinous rings in some of its suckers (p. 103).

In *S. bandensis* the shell is very flat, the inner cone being less developed than in the foregoing species. The tentacular club, with the protective membranes fused at the base, strongly resembles that of *S. apama* and of *S. latimanus*. Moreover, the shell of *S. bandensis* can hardly be distinguished from that of a young *S. apama*, but the latter has a spine and the former only a small posterior knob. The hectocotylus has four rows of normal suckers at the base, followed by seven rows of transformed suckers.

The shell of *S. tuberculata* closely resembles that of *S. bandensis*, but it has no posterior knob. The animal of the former is characterized by the peculiar patches on the ventral side of the mantle and of the ventral arms. The tentacular suckers are more unequal and although the protective membranes are fused at the base of the club the sucker-bearing surface is less detached from the stem. The hectocotylus is transformed in its basal half.

The animal of *S. papillata* can hardly be distinguished from that of *S. tuberculata*, but its tentacular

suckers are still more unequal. The shells are certainly related, but *S. papillata* has narrower limbs of the inner cone and a well-developed posterior knob.

The shell of *S. simoniana* is very similar to that of *S. papillata*, differing only by the lengthening of the posterior part of the inner cone. But the animal is distinctly different, lacking the peculiar ventral patches and possessing a very long tentacular club with minute suckers arranged in 24 series. The hectocotylus is transformed in its proximal half.

The shell of *S. hieronis* strongly resembles that of *S. acuminata*, having a faintly developed inner cone with narrow limbs, but possessing only a slight, blunt, posterior knob instead of a spine. The tentacular club has five series of minute, sub-equal suckers and a very broad dorsal protective membrane. The hectocotylus is transformed in its basal half. Moreover the male and the female have some enlarged suckers on their arms and most or all of their suckers are biserial.

The shell of *S. insignis*, with its long acuminate anterior part, does not seem related to any other known species. Its animal is unknown.

Although all these species have a spine-less shell, there does not seem to exist a close relationship between them. *Sepia dollfusi* and *S. gibba* are very similar and have been placed by some authors in the genus *Lophosepion*. The shell of *S. bandensis* recalls that of Iredale's genus *Blandosepia*. For *S. tuberculata* and *S. papillata*, Rochebrune (1884, p. 93) created the genus *Spathidosepion* and Robson (1924*a*, p. 645) placed *S. hieronis* in the genus *Rhombosepion*. The tentacular club of these species shows important differences: slightly or strongly unequal suckers in eight series, or very minute sub-equal suckers in 24 series.

Sepia pfefferi, for which Hoyle (1885, p. 199) created a sub-genus *Metasepia*, is distinguished by its rhomboidal shell, which is much shorter than the mantle, with a completely chitinous dorsal surface. Its tentacular suckers are very few in number, some of the median ones being enormously developed. The male of this species is unknown, that of the related *S. tullbergi* does not show any hectocotolization. The inner cone is very narrow, there is no spine, but *S. tullbergi* has a kind of posterior keel on the dorsal surface.

These two species are quite different from all the other Sepiidae and for them a sub-genus may be justified.

As for the genus *Hemisepius* which Steenstrup (1875, p. 469) created for *H. typicus*, it seemed amply justified by the characters of both the shell and the animal. The latter has two series of pores at the ventral side of the mantle; the suckers are biserial on all the arms with partly enlarged suckers in the male; the hectocotylus is transformed in its basal two-thirds. The very flat shell has the dorsal surface chitinous, the phragmocone much shorter and the rather broad, rounded limbs completely fused with the outer cone. Unfortunately, the discovery of a second species, *H. dubius*, the male of which is unknown, renders the value of some of the generic characters rather problematic. The animal has biserial arm-suckers, but no ventral pores on the mantle. In both species the tentacular club has four or five series of minute sub-equal suckers. The shell of *H. dubius* has its dorsal surface calcified with a reticulate pattern. The phragmocone has the same characteristic form; the broad limbs of the inner cone are much more distinct than in *H. typicus*.

A third species, *S. robsoni*, seems to be related in the form of the animal, the tentacular club, the hectocotylus and the biserial suckers, but it too lacks the ventral pores, and the dorsal arms of the male (the female is unknown) have fingerlike tips devoid of suckers. The shell of this species is in poor condition, completely chitinous and with its anterior part strongly acuminate; it resembles that of *S. hieronis*. The animal of the latter has some enlarged suckers on its arms, whereas this character is less pronounced in *S. robsoni*. More material of this species is required to establish its relationship with other species.

For the moment we think that the genus or sub-genus *Hemisepius* may be maintained for *H. typicus* and *H. dubius*, but its separation from other Sepiidae has become less distinct.

In the genus *Sepiella*, the animal and the shell possess sufficient characters to distinguish them from all other Sepiidae. The characteristic posterior gland and the form of the locking-apparatus do not occur in any other group. The differences between the species of *Sepiella* are little pronounced and concern principally the general form and proportions of the shell and the tentacular club which shows an increasing number of longitudinal series of suckers: eight to ten in *S. ocellata*, 10 to 14 in *S. ornata*, *S. cyanea* and *S. weberi*, 12 to 24 in *S. inermis* and 16 to 32 in *S. japonica*. The hectocotylus is transformed in its basal half, the arm-suckers of the male are armed with strong distal teeth.

If we summarize the results of this discussion, we see that only in the first group do several species present a number of primitive characters. In all the groups several characters seem to have evolved independently. The recent species represent the present end points in their evolution. It is possible that they illustrate evolutionary trends, but we are not sure that this can be correctly interpreted. We can compare them with a number of twigs or leaves from which we try to reconstruct a tree, but we do not know if they belong to the same stock or to several. Some characters seem to have evolved very little, others have undergone important modifications under the influence of internal or external causes. If we take one character as a starting point, we can classify the species in a certain system, but if we take another character the result of our classification is completely different and we doubt if our knowledge of the recent species of Sepiidae will ever allow a natural classification.

For several species we have been able to establish a close relationship, but only in the case of *Sepiella* can we separate its species without any doubt from all the other Sepiidae. This genus is characterized by a number of characters of the shell and of the animal. The shell seems to be highly evolved in the reduction of the inner cone and the absence (loss?) of a spine, but the tentacular club bears sub-equal suckers in an increasing number of longitudinal series.

In the case of *Hemisepius*, the situation is less clear. In fact, if we consider *dubia* to be a *Hemisepius*, one of the main characters of this genus, the presence of two series of ventral pores, cannot be maintained as a generic character, and the other features of the animal seem to be related to those of some other Sepiidae, like *S. robsoni* and *S. hieronis*. In this case only the shell of *H. typicus* and *H. dubius* permits us to separate them from all other Sepiidae and we prefer to regard *Hemisepius* as a sub-genus. This shell seems to be highly evolved in the reduction of the inner cone and in the absence of a spine, but the short phragmocone leaving a long pro-ostracum presents a very primitive character, unless the phragmocone has regressed.

Likewise, we may consider *Metasepia* as a sub-genus because of its peculiar shell, which is found only in *S. pfefferi* and *S. tullbergi*.

As to all the other species, we do not at present see a possibility of separating them in different genera or sub-genera, either by the characters of the animal or by those of the shell and certainly not by those of both the animal and the shell. The characters of the numerous genera and sub-genera (see p. 132) which have been created, are in each case only valid for one or a few species, but if we consider all the species of Sepiidae the limits become more and more vague and these generic categories purely arbitrary.

V. GEOGRAPHICAL AND BATHYMETRIC DISTRIBUTION

In the following table we have summarized the data on the geographical and bathymetrical distribution. The latter is very imperfectly known; for more than half of all the species no data at all are available; as to the majority of the remaining species we possess only very few records. For a few species with a wide geographical distribution, the bathymetrical distribution seems to be related

to the former. For example: *Sepia elegans* has been mentioned in European waters from depths between 20 and 250 m, whereas this species has been found on the W. African coast between 80 and 430 m. *Sepia orbignyana* shows the same phenomenon—on the European coast between the surface and 100 m depth, but on the W. African coast between 116 and 430 m. But far too little is known to allow any general conclusions.

As to geographical distribution, it is first of all noteworthy that no Sepiidae have ever been found on the coasts of the American continent or on those of New Zealand, except as stranded cuttlebones.

In European waters only three species are known: *S. officinalis*, *S. elegans* and *S. orbignyana*, but these occur also on the W. African coast and *S. officinalis vermiculata* even in S. Africa.

On the W. African coast live three further Sepiidae which are endemic: *S. bertheloti*, *S. elobyana* and *Sepiella ornata*.

The S. African coast is rich in species (about fifteen), most of which (perhaps all of them) are endemic.

Nine species have been reported from the Red Sea, but only three of them, *S. elongata*, *S. dollfusi* and *S. gibba*, seem to be endemic in the highly saline waters of the northern part. The other ones extend into the Indian Ocean and *S. pharaonis* even into the Pacific as far as Japan and Australia.

Japanese waters have a very rich fauna with about fifteen endemic species.

The Australian fauna seems to be far the richest one in endemic species: even without counting the numerous species which are certainly or probably synonymous, there remain still about 20 species which seem to be endemic.

As to the remaining, Indo-Pacific species, many of them have only been found in very restricted areas but too little collecting has been done as to allow a clear picture of their geographical distribution. On the other hand, supplementary data are needed to establish the eventual relationship or even identity among species which have been described from far distant regions: as for example between *S. acuminata* (S. Africa), *S. madokai* (Japan) and *S. rex* (Australia).

The eventual existence of geographical races in Sepiidae can only be studied by means of numerous specimens. Only for *Sepia officinalis* a sub-division in geographical races has been worked out to some degree (see Adam, 1941).

Species	Distribution	Depth in metres	Animal described	Shell described	Remarks
SEPIA					
S. aculeata	Indo-Pacific	8–10	♂ + ♀	×	
S. acuminata	S. Africa	64–350	♂ + ♀	×	
S. andreana	Japan		♂ + ♀	×	
S. apama	Australia		♂ + ♀	×	
S. appellöfi	Japan		♂ + ♀	×	
S. arabica	Indian Ocean; Red Sea	97–270	♂ + ♀	×	
S. australis	S. Africa	2–457	♂ + ♀	×	
S. bandensis	Indian Ocean	12	♂ + ♀	×	
S. bartletti	Australia			×	
S. baxteri	Australia			×	
S. bertheloti	W. Africa	20–156	♂ + ♀	×	
S. brachycheira	New Guinea				insufficiently described.
S. braggi	Australia	139–176		×	
S. brevimana	Indo-Malayan		♂ + ♀	×	See Adam, 1965
S. burnupi	S. Africa	? 40–48	? ♂ + ♀	×	? = *S. exsignata*
S. carinata	Japan		♂ + ♀	×	
S. chirotrema	S. Australia	146–220	♂ + ♀	insufficient	
S. confusa	S. Africa	64–350	♂ + ♀	×	
S. cottesloensis	W. Australia			×	? = *S. rex*
S. cultrata	Australia	275–293	♀	×	
S. dannevigi	S. Australia	36–183	♀		
S. dollfusi	Red Sea	3·5–5·5	♂ + ♀	×	

Species	Distribution	Depth in metres	Animal described	Shell described	Remarks
S. elegans	Europe; W. Africa	20–430	♂ + ♀	×	
S. elliptica	Indo-Pacific	51–1000	♂♂ + ♀♀	×	
S. elobyana	W. Africa		♂ + ♀	×	
S. elongata	Red Sea		♂	×	
S. erostrata	Japan		♂	×	
S. esculenta	Japan		♂ + ♀	×	
S. galei	W. Australia		♂	×	? = *S. papuensis*
S. gemellus	Australia			×	
S. genista	W. Australia			×	? = *S. papuensis*
S. gibba	Red Sea	1	♂ + ♀	×	
S. glauerti	Australia			×	? = *S. mestus*
S. hedleyi	S. Australia	146–?820	♂ + ♀	insufficient	
S. hendryae	W. Australia			×	
S. hieronis	S. Africa	43–420	♂ + ♀	×	
S. incerta	S. Africa	49– 70	♂ + ♀	partly	
S. insignis	S. Africa			×	
S. irvingi	W. Australia		♀	×	? = *S. novaehollandiae*
S. jaenschi	S. Australia			×	? = *S. rex*
S. joubini	S. Africa	66– 99	♂ + ♀	insufficient	
S. kiensis	Arafura Sea	256	♀	×	
S. kobiensis	Japan	15	♂ + ♀	×	
S. lana	Australia			insufficient	? = *S. papuensis*
S. latimanus	Indo-Pacific	4– 27	♂ + ♀	×	
S. liliana	Australia			×	? = *S. mestus*
S. limata	Australia			×	? = *S. braggi*
S. longipes	Japan		♂ + ♀	×	
S. lorigera	Japan		♂♂ + ♀♀	×	
S. lycidas	Indo-Pacific		♂ + ♀	×	
S. macandrewi	Australia			×	? = *S. novaehollandiae*
S. macilenta	Australia			×	not = *S. cultrata*
S. madokai	Japan		♂ + ♀	×	? = *S. acuminata*
S. mestus	Australia; ? China		? ♀	×	
S. mira	Australia			×	
S. misakiensis	Japan		♂	×	? = *S. tokioensis*
S. murrayi	Gulf of Oman	106	♀	×	
S. myrsus	? China			×	? = *S. simoniana*
S. novaehollandiae	Australia			×	
S. occidua	Australia			×	? = *S. papuensis*
S. officinalis	Europe–S. Africa	0–250	♂ + ♀	×	
S. omani	Gulf of Oman	201	♂ + ♀	×	
S. opipara	Australia			×	
S. orbignyana	Europe; W. Africa	0–430	♂ + ♀	×	
S. ostanes	Australia			×	? = *S. novaehollandiae*
S. pageora	Australia		♂	×	? = *S. smithi*
S. papillata	S. Africa	64	♂ + ♀	×	
S. papuensis	Indo-Pacific	51	♂	×	
S. pardalis	Japan		♂	×	
S. parysatis	W. Australia			×	? = *S. apama*
S. peterseni	Japan		♂	×	
S. pharaonis	Red Sea, Indo-Pacific	18–1000	♂ + ♀	×	
S. plangon	Australia	5·5	♂♂ + ♀♀	×	
S. prashadi	Red Sea, Indian Ocean	201	♂ + ♀	×	
S. prionota	Sulu Archipelago	44	♀	×	= *S. papuensis*
S. recurvirostra	China; Indo-Pacific	59–90	♂ + ♀	×	= *S. singaporensis*
S. rex	Australia	140–147		×	? = *S. acuminata*
S. rhoda	Australia			×	
S. robsoni	S. Africa	16– 37	♂	insufficient	
S. rozella	Australia			×	
S. savignyi	Red Sea; Persian Gulf	27– 73	♂ + ♀	×	
S. sewelli	E. Africa	37–238	♀	×	
S. simoniana	S. Africa	64–134	♂ + ♀	×	
S. smithi	Arafura Sea	51	♀	×	
S. subaculeata	Japan		♂ + ♀	×	? = *S. lycidas*
S. submestus	Australia			×	

Species	Distribution	Depth in metres	Animal Described	Shell Described	Remarks
S. sulcata	Arafura Sea	256	♂	insufficient	
S. tenuipes	Japan		♂ + ♀	×	
S. thurstoni	Indian Ocean	22– 37	♂ + ♀	×	
S. tokioensis	Japan		♂	×	
S. treba	Australia			×	? = *S. braggi*
S. trygonina	Red Sea; Indian Ocean	37–413	♂ + ♀	×	
S. tuberculata	S. Africa		♂ + ♀	×	
S. venustoides	Zanzibar; S. Nilandu Atoll	66	juv.	×	? = *S. pharaonis*
S. versuta	Australia			×	? = *S. braggi*
S. whitleyana	E. Australia			×	? = *S. elliptica*
S. zanzibarica	E. Africa		♂ + ♀	×	
SEPIA (METASEPIA)					
S. pfefferi	Arafura Sea; Australia	51	♀	×	
S. tullbergi	Japan		♂ + ♀	×	
SEPIA (HEMISEPIUS)					
S. dubia	S. Africa		♀	×	
S. typica	S. Africa	2·5–47	♂ + ♀	×	
SEPIELLA					
S. cyanea	S. Africa	37	♂ + ♀	×	
S. inermis	Red Sea; Indian Ocean		♂♂ + ♀	×	
S. japonica	China; Japan		♂ + ♀	×	
S. melwardi	Australia	? 73		×	
S. ocellata	Java		♂	×	
S. ornata	W. Africa	11–143	♂ + ♀	×	
S. weberi	Timor; Soemba	0–18	♂ + ♀	×	

VI. ALPHABETICAL LIST OF DESCRIBED GENERA AND SUB-GENERA OF SEPIIDAE

Acanthosepion Rochebrune, 1884 (p. 100).
Type species: *Sepia aculeata* Férussac & d'Orbigny, 1835–1848.

Amplisepia Iredale, 1926 (p. 194).
Type species: *Sepia apama* Gray, 1849; original designation.
According to Thiele (1934, p. 954) this genus is a synonym of *Ascarosepion*, but his opinion is based on the erroneous interpretation by Iredale of *Ascarosepion verreauxi* Rochebrune; the latter species has nothing in common with *Sepia apama*.

Andreaesepia Grimpe, 1922 (p. 44).
Type species: *Sepia andreana* Steenstrup, 1875; original designation.
=*Doratosepion* Rochebrune, 1884.

†*Archaeosepia* Szörenyi, 1933 (p. 186).
Type species: †*A. naefi* Szörenyi, 1933.

Arctosepia Iredale, 1926 (p. 193).
Type species: *A. limata* Iredale, 1926; original designation.

Ascarosepion Rochebrune, 1884 (p. 98).
Type species: *A. verreauxi* Rochebrune, 1884 (*non* Iredale, 1926); designated by Hoyle (1910, p. 408).
Synonym: *Solitosepia* Iredale, 1926.

†*Belosepia* Voltz, 1830 (p. 410).
Type species: †*Belosepia cuvieri* Voltz, 1830.
According to Bülow-Trummer (1920, p. 242), the type of *Belosepia* is *B. blainvillei* Desh. and *B. cuvieri* Voltz, a synonym of *B. sepioidea* Blainville.

Blandosepia Iredale, 1940 (p. 442).
Type species: *B. baxteri* Iredale, 1940; original designation.

†*Campylosepia* Picard, 1899 (p. 308).
Type species: †*C. triasica* Picard, 1899.

Crumenasepia Iredale, 1926 (p. 239).
Type species: *C. hulliana* Iredale, 1926; original designation.

Decorisepia Iredale, 1926 (p. 193).
Type species: *D. rex* Iredale, 1926; original designation.

Diphtherosepion Rochebrune, 1884 (p. 79).
Type species: *Sepia ornata* Rang, 1837, designated by Hoyle (1910, p. 408).
= *Sepiella* Gray, 1948.

Doratosepion Rochebrune, 1884 (p. 95).
Type species: *Sepia andreana* Steenstrup, 1875, designated by Hoyle (1910, p. 409).
Synonym: *Andreaesepia* Grimpe, 1922.

Eusepia Naef, 1923 (p. 545) (sub-genus).
Type species: *Sepia officinalis* Linné, 1758; original designation.
= *Sepia* Linné, 1758.

Fiscisepia Iredale, 1926 (p. 239) (sub-genus).
Type species: *Acanthosepion ellipticum adjacens* Iredale, 1926; original designation.
= *Platysepia* Naef, 1923.

Glyptosepia Iredale, 1926 (p. 191).
Type species: *G. opipara* Iredale, 1926; original designation.

Hemisepius Steenstrup, 1875 (p. 465).
Type species: *H. typicus* Steenstrup, 1875 (monotypic genus).

Lophosepion Rochebrune, 1884 (p. 90).
Type species: *Sepia lefebrei* d'Orbigny, 1845.

Mesembrisepia Iredale, 1926 (p. 191).
Type species: *M. macandrewi* Iredale, 1926; original designation.

Metasepia Hoyle, 1885 (p. 199) (sub-genus).
Type species: *M. pfefferi* Hoyle, 1885 (monotypic sub-genus).

Parasepia Naef, 1923 (p. 545) (sub-genus).
Type species: *Sepia orbignyana* Férussac, 1826; original designation.

Platysepia Naef, 1923 (p. 546) (sub-genus).
Type species: *Sepia esculenta* Hoyle, 1885; original designation.
Synonym: *Fiscisepia* Iredale, 1926.

Ponderisepia Iredale, 1926 (p. 239).
Type species: *P. eclogaria* Iredale, 1926; original designation.

†*Pseudosepia* Naef, 1923 (p. 794).
Type species: †*Sepia vera* Deshayes, 1863; original designation.

Rhombosepion Rochebrune, 1884 (p. 82).
Type species: *Sepia rupellaria* Férussac & d'Orbigny, 1835–1848, designated by Hoyle (1910, p. 412).

Sepia Linné, 1758 (p. 658).
Type species: *Sepia officinalis* Linné, 1758, designated by Hoyle (1910, p. 412).[1]
According to Bülow-Trummer (1920, p. 246), the author of *Sepia* is Lamarck (1801) and the type: *S. vera* Deshayes, 1863![2]

[1] Mayer (1885, p. 23) is in error in citing *S. latimanus* as the type species of *Sepia*; this species was not among the species originally listed by Linnaeus (1758, pp. 658–659).

[2] Of the species originally listed under *Sepia*, only *S. officinalis* remains, the other species having been removed to other genera.

Sepiella Gray, 1849 (p. 106).
Type species: *Sepia ornata* Rang, 1837, designated by Hoyle (1910, p. 412).
Synonym: *Diphtherosepion* Rochebrune, 1884.

Solitosepia Iredale, 1926 (p. 188).
Type species: *S. liliana* Iredale, 1926; original designation.
= *Ascarosepion* Rochebrune, 1884.

Spathidosepion Rochebrune, 1884 (p. 93).
Type species: *Sepia tuberculata* Lamarck, 1798, designated by Hoyle (1910, p. 413).

†*Stenosepia* Vincent, 1901 (p. 20) (sub-genus of *Belosepia*).
Type species: †*Beloptera compressa* Blainville, 1827.

Tenuisepia Cotton, 1932 (p. 546).
Type species: *T. mira* Cotton, 1932; original designation.

VII. ALPHABETICAL LIST OF SPECIES, SUB-SPECIES AND VARIETIES OF SEPIIDAE[1]

†*aalensis* (*Sepialites*), Hehl, 1850, p. 206 = ***Geoteuthis bollensis*** (v. Zieten 1830, p. 34, pl. XXV, fig. 6) (see *Foss. Cat.* **1**, 11, p. 253, 1920).
aculeata (Sepia), Férussac & d'Orbigny, 1835–1848, p. 287, pls. 5 *bis*, 25 . . . . . p. 12
acuminata (Sepia), Smith, 1916, p. 21, pl. II, figs. 3 & 4 . . . . . p. 53
adhaesa (sub-sp. of ***Solitosepia plangon*** (Gray)), Iredale, 1926, p. 238 . . . . . p. 42
adjacens (sub-sp. of ***Acanthosepion (Fiscisepia) ellipticum*** (Hoyle)), Iredale, 1926, p. 239, pl. XXXV, figs. 5 & 6 p. 16
affinis (*Sepia*), Férussac, 1826, p. 156 = ***? Sepioteuthis sepioidea*** Blainville, 1823, p. 133 (see d'Orbigny, 1845, p. 300)
affinis (*Sepia*), Eydoux & Souleyet, 1852, p. 35, pl. 3, figs. 13 & 14 = ***Sepiella inermis*** (Férussac & d'Orbigny, 1835–1848). . . . . p. 124
†***agriensis (Sepia)***, Wagner, 1938, p. 187, 196, fig. 188
albatrossi (var. of ***Sepia kobiensis*** Hoyle), Sasaki, 1920, p. 195, pl. 26, figs. 2 & 3. . . . . p. 71
andreana (Sepia). Steenstrup, 1875, p. 473, pl. I, figs. 11–19 . . . . . p. 75
andreanoides (*Sepia*), Hoyle, 1885, p. 193 = ***Sepia kobiensis*** Hoyle, 1885 . . . . . p. 71
antillarum (Sepia), d'Orbigny, 1838, p. 33 (doubtful species).
†*antiqua* (*Sepia*), Münster, 1837, p. 252 (nomen nudum); 1842, pl. IX, figs. 4 & 5 = ***Trachyteuthis antiqua*** (see *Foss. Cat.*, **1**, 11, p. 249, 1920).
apama (Sepia), Gray, 1849, p. 103 . . . . . p. 34
appellöfi (Sepia), Wülker, 1910, p. 14, figs. 8, 15–18 . . . . . p. 60
arabica (Sepia), Massy, 1916, p. 228, pl. XXIII, figs. 1–5; pl. XXIV, fig. 10 . . . . . p. 96
australis (Sepia), Quoy & Gaimard, 1832, p. 70, pl. 5, figs. 3–7 . . . . . p. 89
australis (*Sepia*), Férussac & d'Orbigny, 1835, pl. 7, fig. 4 = ***Sepia novaehollandiae*** Hoyle, 1909 . . . . p. 48

bandensis (Sepia), Adam, 1939, p. 1, figs. 1–4 . . . . . p. 104
bartletti (Blandosepia), Iredale, 1954, p. 67, pl. V, figs. 15 & 16. . . . . p. 106
baxteri (Blandosepia), Iredale, 1940, p. 442 . . . . . p. 105
beppuana (var. of ***Sepia kobiensis*** Hoyle), Sasaki, 1929, p. 211, fig. 116, pl. XIX, figs. 13–15. . . . . p. 71
bertheloti (Sepia), d'Orbigny, 1839, p. 21, pl. II . . . . . p. 57
†***bertii (Sepia)***, Foresti, 1890, p. 341, pl. VII (see *Foss. Cat.*, **1**, 11, p. 246, 1920)
bilineata (*Sepia*), Quoy & Gaimard, 1832, p. 66, pl. 2, fig. 1 = ***Sepioteuthis bilineata*** (see d'Orbigny, 1845, p. 300).
biserialis (*Sepia*), Blainville, 1827, p. 284 = ***? Sepia elegans*** Blainville, 1827 . . . . . p. 94
bisserialis (*Sepia*), Verany, 1851, p. 73, pl. XXVI, figs. f–k = ***Sepia elegans*** Blainville, 1827 . . . . . p. 94
†*blainvillii* (*Sepia*), Deshayes, 1835, p. 758, pl. 101, figs. 13–15 = *Beloptera sepioidea* Blainville, 1825, p. 622, pl. XI, fig. 7 (see d'Orbigny, 1845, p. 269) = ***Belosepia sepioidea*** (see *Foss. Cat.*, **1**, 11, p. 244, 1920).
blainvillei (*Sepia*), Férussac & d'Orbigny, 1848, pl. 21 = *Sepia indica* Férussac & d'Orbigny, 1848, p. 288, pl. 21 = ***Sepia aculeata*** Férussac & d'Orbigny, 1835–1848. . . . . p. 12
boscii (*Sepia*), Lesueur, 1821, p. 101 = ***Octopus boscii*** (doubtful species).
brachycheira (Sepia), Tapparone-Canefri, 1877, p. 278 (doubtful species).
braggi (Sepia), Verco, 1907, p. 213, pl. XXVII, fig. 6 . . . . . p. 79
brevimana (Sepia), Steenstrup, 1875, pp. 475, 479; 1881, p. 223, pl. I, figs. 24–26 . . . . . p. 5
†*brevispina* (*Sepia*), Sowerby, 1850, p. 193 = ***Belosepia brevispina*** (see *Foss. Cat.* **1**, 11, p. 242, 1920).
burnupi (Sepia), Hoyle, 1904, p. 27, pl. I. . . . . p. 81

[1] For the fossil species (†) we have only mentioned the names connected with the generic names *Sepia* and *Sepialites*.

capensis (*Sepia*), Férussac & d'Orbigny, 1835–1848, p. 278, pl. 7, figs. 1–3, pl. 12, figs. 7–11; pl. 17, figs. 18–19 = ***Sepia australis*** Quoy & Gaimard, 1832 . . . . . .p. 89
†caralitana (Sepia), Gennari, 1867, p. 21 (see *Foss. Cat.* **1,** 11, p. 246, 1920).
cardioptera (*Sepia*), Oken, 1815, p. 343 = *Onychoteuthis cardioptera* (see d'Orbigny, 1845, p. 300) = ***Onychia carribaea*** Lesueur, 1821.
carinata (Sepia), Sasaki, 1920, p. 192, pl. XXV, fig. 2; pl. XXVI, fig. 1 . . . . . .p. 76
carunculata (*Sepia*), Schneider, 1788, p. 42 = ***Loligo carunculata*** (see d'Orbigny, 1845, p. 300).
†*caudata* (*Sepia*), Münster, 1837, p. 252 (nomen nudum), d'Orbigny, 1845 (Pal. univ.), pl. V, figs. 1–3 = ***Trachyteuthis caudata*** (see *Foss. Cat.* **1,** 11, p. 249, 1920).
chirotrema (Sepia), Berry, 1918, p. 268, pl. LXXIV, figs. 3–9, pl. LXXV–LXXVII, text-figs. 57–61 . . .p. 51
chrysophtalmos (*Sepia*), Tilesius, 1813, pl. 38 (88?), figs. 32 & 33 = ***Loligopsis chrysophtalmos*** (see d'Orbigny, 1845, p. 300).
chuni (var. of ***Hemisepius typicus*** Steenstrup), Thore, 1945, p. 50 . . . . . .p. 118
cirrhosa (*Sepia*), Bosc, 1802, p. 47 = ***Eledone cirrhosa*** (see d'Orbigny, 1845, p. 300).
†complanata (Sepia), Bellardi, 1872, p. 18, pl. II, fig. 6 (see *Foss. Cat.* **1,** 11, p. 247, 1920).
†*compressa* (*Sepia*), d'Orbigny, 1845, p. 271 = *Beloptera compressa* Blainville, 1827, p. 110, pl. IV, fig. 10 = ***Belosepia (Stenosepia) compressa*** (see *Foss. Cat.* **1,** 11, p. 246, 1920).
confusa (Sepia), Smith, 1916, p. 24, pl. II, figs. 7 & 8 . . . . . .p. 65
cottesloensis (Decorisepia), Cotton, 1929, p. 90, pl. XVI, figs. 1 & 2 . . . . . .p. 56
crassa (var. of ***Sepia kobiensis*** Hoyle), Sasaki, 1929, p. 213, pl. XIX, figs. 16–18 . . . . . .p. 71
cultrata (Sepia), Hoyle, 1885, p. 198 . . . . . .p. 58
curta (*Sepiella*), Pfeffer, 1884, p. 13, figs. 16, 16*a* = ***Sepiella inermis*** (Férussac & d'Orbigny, 1835–1848) . .p. 124
†*cuspidata* (*Sepia*), Simpson, 1855, p. 21 = ***Teudopsis cuspidata*** (see *Foss. Cat.* **1,** 11, p. 258, 1920).
†*cuvieri* (*Sepia*), d'Orbigny, 1824, p. 482 = ***Belosepia cuvieri*** (see *Foss. Cat.* **1,** 11, p. 243, 1920).
†*cuvieri* (*Sepia*), Deshayes, 1835, p. 758, pl. 101, figs. 7 & 8 = *Sepia oweni* Sowerby, 1829, p. 183 = ***Belosepia oweni*** (see *Foss. Cat.* **1,** 11, p. 243, 1920).
†*cuvieri* (*Sepia*), Galeotti (pars), 1837, p. 140 = ***Belosepia proxima*** Vincent, 1901, p. 14 (see *Foss. Cat.* **1,** 11, p. 244, 1920).
cyanea (Sepiella), Robson, 1924, p. 13 . . . . . .p. 121

dabryi (*Diphtherosepion*), Rochebrune, 1884, p. 81 = ***Sepiella japonica*** Sasaki, 1929 . . . . . .p. 128
dannevigi (Sepia), Berry, 1918, p. 264, figs. 51–55, pl. LXXIII, LXXIV, figs. 1 & 2 . . . . . .p. 48
†*defrancii* (*Sepia*), Deshayes, 1835, p. 759, pl. 101, figs. 1–3 = ***Belosepia (Stenosepia) compressa*** Blainville, 1827 (see *Foss. Cat.* **1,** 11, p. 246, 1920).
dollfusi (Sepia), Adam, 1941, p. 12, pl. II, fig. 3 . . . . . .p. 98
dubia (Sepia (Hemisepius)) sp. nov. . . . . .p. 119
dunensis (*Sepia*), Chenu, 1859, p. 45, fig. 138 = ***Palaeoteuthis dunensis*** Roemer, 1856, p. 74, pl. XIII (see *Foss. Cat.* **1,** 11, p. 271, 1920).

eclogaria (*Ponderisepia*), Iredale, 1926, p. 239, pl. XXXV, figs. 7 & 8 = ***Sepia latimanus*** Quoy & Gaimard, 1832 .p. 33
elegans (Sepia), Blainville, 1827, p. 284 . . . . . .p. 94
elliptica (Sepia), Hoyle, 1885, p. 189 . . . . . .p. 14
elobyana (Sepia), Adam, 1941, p. 121, fig. 12, pl. III, fig. 5 . . . . . .p. 103
elongata (Sepia), d'Orbigny, 1845, p. 289, pl. 13, figs. 7–10 . . . . . .p. 86
elongata (*Sepia*), Tate & May, 1901, p. 351 = ***Sepia braggi*** Verco, 1907 . . . . . .p. 79
enoplon (*Acanthosepion*), Rochebrune, 1884, p. 108 = ***Sepia orbignyana*** Férussac, 1826. . . . . .p. 87
†*ensiformis* (*Sepia*), Chenu, 1859, p. 45, fig. 133 = *Trachyteuthis ensiformis* (pars) v. Meyer, 1856, p. 108, pl. XIX, fig. 2 = ***Trachyteuthis caudata*** Münster, 1837 (see *Foss. Cat.* **1,** 11, p. 249, 1920).
erostrata (Sepia), Sasaki, 1929, 183, pl. XVII, figs. 7–9 . . . . . .p. 75
esculenta (Sepia), Hoyle, 1885, p. 188 . . . . . .p. 18
exsignata (Sepia), Barnard, 1962, p. 250, fig. 3 . . . . . .p. 83

filliouxi (sub.-sp. of ***Sepia officinalis*** Linné), Lafont, 1868, No. 81, 1869, p. 11 . . . . . .p. 32
fischeri (*Sepia*), Lafont, 1871, p. 271 = ? ***Sepia filliouxi*** Lafont, 1868 (see Cuénot, 1927, p. 273) .
formosana (*Sepia*), Berry, 1912, p. 420, pl. IX, fig. 7, text-fig. 2 = ***Sepia pharaonis*** Ehrenberg, 1831 . . .p. 22
foxi (var. of *Ascarosepion singhalensis* (Goodrich)), Robson, 1927, p. 325 = ***Sepia pharaonis*** Ehrenberg, 1831 . .p. 22
framea (*Sepia*), Ortmann, 1891, p. 675, pl. XLVI, fig. 2 = ***Sepia pharaonis*** Ehrenberg, 1831. . . . .p. 22

†*gaillardoti* (*Sepia*), Keferstein, 1834, p. 551 = *Conchorhynchus gaillardoti* (see d'Orbigny, 1845, p. 300) = ***Conchorhynchus avirostris*** (Schlotheim, 1820, p. 169, pl. 29, fig. 10), (see d'Orbigny, 1845, p. 590).
galei (Sepia), Meyer, 1909, p. 332, figs. 4–6 . . . . . .p. 40

†***gastaldi (Sepia)***, Bellardi, 1872, p. 14, pl. I, fig. 3 (see *Foss. Cat.* **1**, 11, p. 247, 1920).
gemellus (Glyptosepia), Iredale, 1926, p. 192, pl. XXII, figs. 1 & 2 . . . . . .p. 60
genista (Solitosepia), Iredale, 1954, p. 66, pl. V, figs. 17 & 18 . . . . . .p. 40
gibba (Sepia), Ehrenberg, 1831, No. 2. . . . . .p. 100
gibbosa (*Sepia*), Orbigny, 1845, p. 287 = ***Sepia gibba*** Ehrenberg, 1831 . . . . . .p. 100
†*gigantea* (*Sepia*), Keferstein, 1834, p. 551 = ***Nautilus giganteus*** (see d'Orbigny, 1845, p. 300).
gigas (*Sepia*), Oken, 1815, p. 344 = ***"Poulpe colossal"*** (see d'Orbigny, 1845, p. 300).
glauerti (Solitosepia), Cotton, 1929, p. 87, pl. XIV, figs. 3 & 4 . . . . . .p. 47
goreense (*Acanthosepion*), Rochebrune, 1884, p. 109 = ***Sepia officinalis hierredda*** Rang, 1837 (see Adam, 1941, p. 107).
†*gracilis* (*Sepia*), Münster, 1837, p. 252 (nomen nudum); Férussac & d'Orbigny, 1848, pl. XVI, fig. 5 = *Sepia linguata* Münster, 1837 (see d'Orbigny, 1845, p. 268) = ***Trachyteuthis linguata*** (see *Foss. Cat.* **1**, 11, p. 250, 1920).
†*gracilis* (*Sepialites*), Münster, 1843, p. 77, pl. XIV, fig. 5 = ***Beloteuthis schübleri*** v. Zieten, 1830, pl. XXXVII, fig. 1 (see *Foss. Cat.* **1**, 11, p. 260, 1920).
†***granosa (Sepia)***, Bellardi, 1872, p. 16, pl. II, fig. 2 (see *Foss. Cat.* **1**, 11, p. 247, 1920).
granulata (*Sepia*), Bosc, 1802, p. 47 = ***Octopus rugosus*** Bosc, 1792 (see d'Orbigny, 1845, p. 300)[1]
†***graversii (Sepia)***, Gastaldi, 1868, p. 226, pl. IV. (see *Foss. Cat.* **1**, 11, p. 247, 1920).
gröenlandica (*Sepia*), Dewhirst, 1834, p. 263 = ***? Bathypolypus arcticus*** (Prosch, 1849).

†***harmati (Sepia)***, Szörenyi, 1933, p. 184, pl. I, figs. 4–6, 10.
harmeri (*Sepia*), Robson, 1928, p. 8, figs. 2 & 3 = ***Sepia latimanus*** Quoy & Gaimard, 1832. . . . . .p. 33
hasselti (*Acanthosepion*), Rochebrune, 1884, p. 101 = ***Sepia aculeata*** Férussac & d'Orbigny, 1835–1848 . . .p. 12
†*hastiformis* (*Sepia*), Rüppell, 1829, p. 9, pl. 3, fig. 2 = ***Trachyteuthis hastiformis*** (see *Foss. Cat.* **1**, 11, p. 249, 1920).
†*haustrum* (*Sepia*), Simpson, 1855, p. 21 = ***Geoteuthis coriacea*** Quenstedt, 1846–1849, p. 412, pl. XXXIV, figs. 5 & 6 (see *Foss. Cat.* **1**, 11, p. 254, 1920).
hedleyi (Sepia), Berry, 1918, p. 258, figs. 48–50, pls. LXXI–LXXII . . . . . .p. 60
hendryae (Solitosepia), Cotton, 1929, p. 87, pl. XV, figs, 1 & 2 . . . . . .p. 60
hercules (*Sepia*), Pilsbry, 1894, p. 144 = ***Sepia latimanus*** Quoy & Gaimard, 1832 . . . . . .p. 33
hexapus (*Sepia*), Molina, p. 175 = ***"insecte"*** (see d'Orbigny, 1845, p. 300).
heylei (*Sepiella*), Sasaki, 1929, p. 221, fig. 170 = ***Sepiella japonica*** Sasaki, 1929 . . . . . .p. 128
hieronis (Rhombosepion), Robson, 1924, p. 645, pl. II, figs. 9–11 . . . . . .p. 112
hierredda (Sepia), Rang, 1837, p. 75, pl. 100 = ***Sepia officinalis hierredda*** . . . . . .p. 31
†*hirundo* (*Sepia*), Keferstein, 1834, p. 551 = ***Nautilus hirundo*** (see d'Orbigny, 1845, p. 300).
hoylei (*Sepia*), Ortmann, 1888, p. 650, pl. XXII, fig. 5*a–c*, pl. XXIII, fig. 1*a–c* = ***Sepia esculenta*** Hoyle, 1885. .p. 18
hulliana (*Crumenascpia*), Iredale, 1926, p. 239, pl. XXXV, figs. 1 & 2 = ***Sepia pharaonis*** Ehrenberg, 1831 . .p. 22
†***hungarica (Sepia)***, Lörenthey, 1898, p. 268, pl. III (see *Foss. Cat.*, **1**, 11, p. 247, 1920).

incerta (Sepia), Smith, 1916, p. 23, pl. II, fig. 6 . . . . . .p. 67
indica (*Sepia*), Férussac & d'Orbigny, 1848, p. 288, pl. 21 = ***Sepia aculeata*** Férussac & d'Orbigny, 1835–1848. .p. 12
inermis (*Sepia*), Férussac & d'Orbigny, 1835–1848, p. 286, pl. 6 *bis*., pl. 20, figs. 1–9 = ***Sepiella inermis*** . . .p. 123
insignis (Sepia), Smith, 1916, p. 25, pl. II, fig. 10 . . . . . .p. 114
irvingi (Sepia), Meyer, 1909, p. 333, figs. 7–10 . . . . . .p. 51
†***isseli (Sepia)***, Bellardi, 1872, p. 19, pl. II, fig. 7 (see *Foss. Cat.* **1**, 11, p. 247, 1920).
italica (*Sepia*), Risso, 1854, p. 13, pl. V, figs. 1 & 2 = ***Sepia elegans*** Blainville, 1827. . . . . .p. 94

jaenschi (Decorisepia), Cotton, 1931, p. 41, figs. 5 & 6 . . . . . .p. 55
japonica (Sepiella), Sasaki, 1929, p. 219, fig. 170, pl. XVIII, figs. 20–23; pl. XIX, fig. 28 . . . .p. 128
javanicum (*Acanthosepion*), Rochebrune, 1884, p. 110 = ***Sepia aculeata*** Férussac & d'Orbigny, 1835–1848 . .p. 12
joubini (Sepia), Massy, 1927, p. 161, pl. XVIII . . . . . .p. 70
jousseaumi (*Sepia*), Rochebrune, 1884, p. 117 = ***Sepia officinalis vermiculata*** Quoy & Gaimard, 1832 . .p. 30
jurujubai (var. of *Sepia officinalis* Linné), Oliveira, 1940, p. 29 = ***Sepioteuthis sepioidea*** Blainville, 1823, p. 133

kiensis (Sepia), Hoyle, 1885, p. 194 . . . . . .p. 78
†***kiscellensis (Sepia)***, Wagner, 1938, pp. 183, 194, fig. 2
kobiensis (Sepia), Hoyle, 1885, p. 195. . . . . .p. 71
koettlitzi (*Sepia*), Hoyle, 1901, p. 1, pl. I = ***Sepia pharaonis*** Ehrenberg, 1831 . . . . . .p. 22

[1] d'Orbigny mentions "*Sepia granulosa*" Bosc.

lana (Solitosepia), Iredale, 1954, p. 66 . . . . . .p. 40
†*larus* (*Sepia*), Keferstein, 1834, p. 551 = ***Rhynchoteuthis larus*** (see d'Orbigny, 1845, pp. 300, 596)
latimanus (Sepia), Quoy & Gaimard, 1832, p. 68, pl. 2, figs. 2–11 . . . . . .p. 33
laxior (sub-sp. of ***Metasepia pfefferi*** (Hoyle)), Iredale, 1926, p. 240, pl. XXXV, figs. 9 & 10. . . . .p. 116
lefebrei (*Sepia*), d'Orbigny, 1845, p. 288, pl. 13, figs. 5 & 6 = ***Sepia gibba*** Ehrenberg, 1831 . . . . .p. 100
liliana (Solitosepia), Iredale, 1926, p. 188, pl. XXI, figs. 1–3 . . . . . .p. 47
limata (Arctosepia), Iredale, 1926, p. 193, pl. XXIII, figs. 7 & 8 . . . . . .p. 80
†*linguata* (*Sepia*), Münster, 1837, p. 252 (nomen nudum); d'Orbigny, 1845 (Pal. univ.), p. 162, pl. VI, figs. 4–6 = ***Trachyteuthis linguata*** (see *Foss. Cat.* **1**, 11, p. 250, 1920).
loligo (*Sepia*), Linné, 1758, p. 659; 1767, p. 1096 = ***Loligo vulgaris*** Lamarck, 1798.
loligo (*Sepia*), Gmelin, 1789, p. 3150 = ***Todarodes sagittatus*** Lamarck, 1799 (see d'Orbigny, 1845, p. 300).
loligo (*Sepia*), Fabricius, 1780, p. 359 = *Onychoteuthis banksii* (Leach, 1817) (see d'Orbigny, 1845, p. 300) = ***Gonatus fabricii*** (Lichtenstein, 1818) (see Hoyle, 1886a, p. 252).
longipes (Sepia), Sasaki, 1914, p. 619, pl. XII, figs. 4 & 5 . . . . . .p. 69
†*longirostris* (*Sepia*), Deshayes, 1835, p. 757, pl. 101, figs. 10–12 = *Beloptera sepioidea* Blainville, 1825, p. 621, pl. XI, fig. 7 (see d'Orbigny, 1845, p. 269) = ***Belosepia sepioidea*** (see *Foss. Cat.* **1**, 11, p. 244, 1920).
†*longispina* (*Sepia*), Deshayes, 1835, p. 757, pl. 101, figs. 4–6 = *Beloptera sepioidea* Blainville, 1825, p. 621, pl. XI, fig. 7 (see d'Orbigny, 1845, p. 269) = ***Belosepia sepioidea*** (see *Foss. Cat.* **1**, 11, p. 244, 1920).
†lörentheyi (Sepia), Kretzoi, 1942, p. 124; nom. nov. for *Sepia mediterranea* Lörenthey, 1911 (*non* Ninni, 1884)
lorigera (Sepia), Wülker, 1910, p. 12, figs. 3, 4, 11–14 . . . . . .p. 69
†lovisatoi (Sepia), Parona, 1892, p. 5, pl. III, figs. 3–5 (see *Foss. Cat.* **1**, 11, p. 247, 1920).
lutea (var. of *Sepia officinalis* Linné), Risso, 1854, p. 11 (nomen nudum)
lycidas (Sepia), Gray, 1849, p. 103 . . . . . .p. 8

macandrewi (Mesembrisepia), Iredale, 1926, p. 191, pl. XXI, figs. 8 & 9 . . . . . .p. 48
macilenta (*Glyptosepia*), Iredale, 1926, p. 192, pl. XXII, figs. 3 & 4 = ***? Sepia cultrata*** Hoyle, 1885 (see Iredale, 1955, p. 79). . . . . .p. 59
madokai (Sepia), Adam, 1939, p. 77; nom. nov. for *Sepia robsoni* Sasaki, 1929 (*non* Massy, 1927) . . .p. 56
maindroni (*Sepiella*), Rochebrune, 1884, p. 89 = ***Sepiella inermis*** (Férussac & d'Orbigny, 1835–1848). . .p. 124
mammilata (*Sepia*), Férussac & d'Orbigny, 1835–1848, p. 277 (*S. mamillata*), pl. IV *bis* (*S. mammilata*) = ***? Sepia tuberculata*** Lamarck, 1798 . . . . . .p. 106
martini (*Diphtherosepion*), Rochebrune, 1884, p. 81 = ***Sepiella inermis*** (Férussac & d'Orbigny, 1835–1848) . .p. 124
media (*Sepia*), Linné, 1758, p. 659; 1767, p. 1095 = ***Alloteuthis media*** (see d'Orbigny, 1845, p. 301).
media (*Sepia*), Barbut, 1788, p. 75, pl. VIII, fig. 3 = ***Todarodes sagittatus*** (see d'Orbigny, 1845, p. 301).
mediterranea (sub-sp. of ***Sepia officinalis*** Linné), Ninni, 1884, p. 159.
†*mediterranea* (*Sepia*), Lörenthey, 1909–1913, p. 406 (*non* Ninni, 1884) = ***Sepia lorentheyi*** Kretzoi, 1942.
melwardi (Sepiella), Iredale, 1954, p. 78, pl. V, figs. 1–6 . . . . . .p. 127
mercatoris (*Sepia*), Adam, 1937, p. 56, figs. 6–10 = ***Sepia bertheloti*** Orbigny, 1839 . . . . . .p. 57
mestus (Sepia), Gray, 1849, p. 108 . . . . . .p. 45
†michelotti (Sepia), Gastaldi, 1868, p. 226, pl. 5 (see *Foss. Cat.* **1**, 11, p. 247, 1920).
microcheirus (*Sepia* (*Sepiella*)), Gray, 1849, p. 107 = ***Sepiella inermis*** (Férussac & d'Orbigny, 1835–1848) . .p. 124
microcotyledon (*Sepia*), Ortman, 1891, p. 673, pl. XLVI, fig. 1 = ***Sepia aculeata*** Férussac & d'Orbigny, 1835–1848 .p. 127
minima (*Sepia*), Lesueur, 1821, p. 100 (nomen nudum) = *Sepia sepiola* Péron (*non* Linné) = ?.
minor (*Sepia*), Seba, 1758, pl. III, figs. 5 & 6 = ***Todarodes sagittatus*** (see d'Orbigny, 1845, p. 300).
mira (Tenuisepia), Cotton, 1932, p. 546, figs. 7–9 . . . . . .p. 87
misakiensis (Sepia), Wülker, 1910, p. 15, figs. 5, 6, 19–22 . . . . . .p. 76
moschata (*Sepia*), Bosc, 1802, p. 48 = ***Eledone moschata*** Lamarck, 1798.
moschites (*Sepia*), Herbst, 1788, p. 80 = ***Eledone cirrhosa*** (Bosc, 1802) (see d'Orbigny, 1845, p. 301).
mozambica (*Sepia*), Rochebrune, 1884, p. 118 = ***? Sepia latimanus*** Quoy & Gaimard, 1832 . . . .p. 33
mucronata (*Sepia*), Rafinesque, 1814, p. 29 (nomen nudum).
murrayi (Sepia), sp. nov. . . . . .p. 63
myrsus (Sepia), Gray, 1849, p. 108 . . . . . .p. 112

natalensis (*Sepia*), Massy, 1925, p. 212, pl. XI, figs. 1–11, pl. XIV, fig. 37 = ***Sepia simoniana*** Thiele, 1921 . .p. 109
nigra (*Sepia*), Bosc, 1802, p. 47 = ***? Dosidicus gigas*** (d'Orbigny, 1835) (see d'Orbigny, 1845, p. 301).
novaehollandiae (Sepia), Hoyle, 1909, p. 266; nom. nov. for *Sepia australis* Férussac & d'Orbigny, 1835–1848 (*non* Quoy & Gaimard, 1832) . . . . . .p. 48

†*obscura* (*Sepia*), Münster, 1837, p. 252 (nomen nudum); 1842, pl. IX, fig. 3 = ***Trachyteuthis antiqua*** (Münster, 1842) (see *Foss. Cat.*, **1**, 11, p. 249, 1920).
obtusata (*Sepiella*), Pfeffer, 1884, p. 15, figs. 19 & 19*a* = ***? Sepiella japonica*** Sasaki, 1929 . . . . p. 128

†*obtusialis* (*Sepia*), Simpson, 1855, p. 20 = ***Geoteuthis coriacea*** Quenstedt, 1846–1849, p. 412, pl. XXXIV, figs. 5 & 6 (see *Foss. Cat.* **1**, 11, p. 253, 1920).
occidua (Solitosepia), Cotton, 1929, p. 88, pl. XIV, figs. 1 & 2 . . . . . p. 40
ocellata (Sepiella), Pfeffer, 1884, p. 13, figs. 17 & 17*a–b* . . . . . p. 127
octopa (*Sepia*), Péron in Lesueur, 1821, p. 101 = *Sepia peronii* Lesueur = ***Octopus pustulosus***[1] Blainville, 1826, p. 186 (see d'Orbigny, 1845, p. 301).
octopodia (*Sepia*), Linné, 1758, p. 658 = ***Octopus vulgaris*** Cuvier, 1797 (see d'Orbigny, 1845, p. 301) = ***Octopus*** and ***Eledone*** (see Robson, 1929, p. 62).
octopodia (*Sepia*), Pennant, 1776, p. 53, pl. XXVIII, fig. 44 = ***Eledone cirrhosa*** Lamarck, 1798 (see d'Orbigny, 1845, p. 301).
octopus (*Sepia*), Gmelin, 1791, p. 3149 = ***Octopus vulgaris*** Cuvier, 1797 (see d'Orbigny, 1845, p. 301).
octopus (*Sepia*), Molina, 1789, p. 173 = ***Octopus fontanianus*** d'Orbigny, 1835 (see d'Orbigny, 1845, p. 301).
oculifera (*Acanthosepion*), Rochebrune, 1884, p. 107 = ***Sepia officinalis hierredda*** Rang, 1837 (animal) and ***Sepia prashadi*** Winckworth, 1936 (shell). . . . . p. 26
officinalis (Sepia), Linné, 1758, p. 658 . . . . . p. 30
†oligocaenica (Sepia), Szörenyi, 1933, p. 184, pl. I, figs. 8 & 9
omani (Sepia) sp. nov. . . . . p. 92
opipara (Glyptosepia), Iredale, 1926, p. 191, pl. XXII, figs. 7 & 8 . . . . . p. 60
orbigniana (Sepia), Férussac (in d'Orbigny), 1826, p. 156 . . . . . p. 87
†*d'orbignyi* (*Sepia*), Keferstein, 1834, p. 551 = ***Rhynchoteuthis larus*** (Keferstein, 1834) (see d'Orbigny, 1845, pp. 301, 596).
ornata (*Sepia*), Rang, 1837, p. 76, pl. 101 = ***Sepiella ornata*** . . . . . p. 127
†*ornata*[2] (*Sepia*), d'Orbigny, 1845 (Pal. univ.) p. 166, pl. III, fig. 12, pl. IV, figs. 1–3 = ***Glyphiteuthis ornata*** (see *Foss. Cat.* **1**, 11, p. 251, 1920).
ostanes (Mesembrisepia), Iredale, 1954, p. 69, pl. IV, figs. 5 & 6 . . . . . p. 52
ovata (*Sepiella*), Pfeffer, 1884, p. 14, figs. 18 & 18*a* = ***? Sepiella japonica*** Sasaki, 1929 . . . . . p. 128
†*oweni* (*Sepia*), Sowerby, 1829, p. 183 = ***Belosepia oweni*** (see *Foss. Cat.* **1**, 11, p. 243, 1920).

pagenstecheri (*Sepia*), Pfeffer, 1884, p. 9, figs. 12, 12*a* = ***? Sepia recurvirostra*** Steenstrup, 1875 . . p. 28
pageorum (Acanthosepion) Iredale, 1954, p. 76, pl. IV, figs. 7–9 . . . . . p. 20
palmata (*Sepia*), Owen, 1881, p. 134, pl.XXIV, XXV = ***? Sepia apama*** Gray, 1849 . . . . . p. 34
papillata (Sepia), Quoy & Gaimard, 1832, p. 61, pl. I, figs. 6–14 . . . . . p. 108
papuensis (Sepia), Hoyle, 1885, p. 197 . . . . . p. 38
pardalis (Sepia), Sasaki, 1914, p. 614, pl. XII, figs. 1–3 . . . . . p. 67
†*parisiensis* (*Sepia*), d'Orbigny, 1826, p. 157 = ***Beloptera belemnitoidea*** Deshayes, 1835, p. 762, pl. 100, figs. 4–6 (see *Foss. Cat.* **1**, 11, p. 235, 1920).
parysatis (Amplisepia), Iredale, 1954, p. 71, pl. IV, figs. 1 & 2 . . . . . p. 38
pelagica (*Sepia*), Bosc, 1802, p. 46, pl. I, figs. 1 & 2 = ***Hyaloteuthis pelagicus*** (see d'Orbigny, 1845, p. 301).
peregrina (sub-sp. of ***Solitosepia rozella*** Iredale), Iredale, 1926, p. 238 . . . . . p. 47
peronii (*Sepia*), Lesueur, 1821, p. 101 (nomen nudum) = *Sepia octopa* Péron (*non* Linné) = ***Octopus pustulosus***[3] Blainville, 1826, p. 186 (see d'Orbigny, 1845, p. 301).
peterseni (Sepia), Appellöf, 1886, p. 23, pl. II, figs. 1–6; pl. III, fig. 21. . . . . p. 75
pfefferi (Sepia (Metasepia)), Hoyle, 1885, p. 199 . . . . . p. 114
pharaonis (Sepia), Ehrenberg, 1831 . . . . . p. 22
plangon (Sepia), Gray, 1849, p. 104 . . . . . p. 42
polynesica (*Sepia*), Pfeffer, 1884, p. 11, figs. 14 & 14*a* = ***? Sepia plangon*** Gray, 1849. . . . . p. 44
prashadi (Sepia), Winckworth, 1936, p. 17, pl. 4. . . . . p. 26
prionota (*Sepia*), Voss, 1926, p. 169 = ***Sepia papuensis*** Hoyle, 1885. . . . . p. 41
†prisca (Sepia), König, 1825, pl. XVII, fig. 201 (see *Foss. Cat.* **1**, 11, p. 267, 1920).

rappiana (*Sepia*), Férussac & d'Orbigny, 1835, pl. 10 = ***Sepia latimanus*** Quoy & Gaimard, 1832 . . p. 33
recurvirostra (Sepia), Steenstrup, 1875, pp. 475, 479 . . . . . p. 28
†*regularis* (*Sepia*), Münster, 1837, p. 252 (nomen nudum); Férussac & d'Orbigny, 1848, pl. 15, fig. 4 = *Sepia linguata* Münster, 1837 (see d'Orbigny, 1845, p. 268) = ***Trachyteuthis linguata*** (see *Foss. Cat.* **1**, 11, pp. 250, 1920).
†regulosa (Sepia), Bellardi, 1872, p. 15, pl. II, fig. 1 (see *Foss. Cat.* **1**, 11, p. 247, 1920).
rex (Decorisepia), Iredale, 1926, p. 193, pl. XXIII, figs. 9 & 10 . . . . . p. 56

[1] d'Orbigny mentions "***Octopus pustulatus***".
[2] This name being preoccupied, it may be replaced by ***ornatoides*** nom. nov.
[3] d'Orbigny mentions "***Octopus pustulatus***".

rhoda (Arctosepia), Iredale, 1954, p. 75, pl. IV, figs. 10–12 . . . . . p. 81
robsoni (Rhombosepion), Massy, 1927, p. 159, pl. XVII . . . . . p. 120
robsoni (*Sepia*), Sasaki, 1929 (*non* Massy, 1927), p. 179, pl. XVII, figs. 2 & 3 = ***Sepia madokai*** Adam, 1939. p. 56
rostrata (Sepia), Férussac & d'Orbigny, 1835, pl. 8, fig. 6 . . . . . p. 56
rostrata (*Sepia*), Férussac & d'Orbigny, 1848 (*non* 1835), p. 284, pl. 26 = ***Sepia brevimana*** Steenstrup, 1875 . p. 5
rostrum (*Sepia*), Hisinger, 1837, = ***"Pollicipes"*** (see d'Orbigny, 1845, p. 301).
rouxii (*Sepia*), Férussac & d'Orbigny, 1848, p. 271, pl. 19 = ***Sepia pharaonis*** Ehrenberg, 1831 . . . . p. 22
rozella (Solitosepia), Iredale, 1926, p. 190, pl. XXI, figs. 6 & 7 . . . . . p. 47
rubens (*Sepia*), Philippi, 1844, p. 203 = ***Sepia orbignyana*** Férussac, 1826. . . . . p. 87
rupellaria (*Sepia*), Férussac & d'Orbigny, 1835–1848, p. 274, pl. 3, figs. 10–13 = ***Sepia elegans*** Blainville, 1827 p. 94
rugosa (*Sepia*), Bosc, 1792, p. 24, pl. 5, figs. 1 & 2 = ***Octopus rugosus*** (see d'Orbigny, 1845, p. 301).
rugosa (*Sepia*), Bowdich, 1822, pl. I, fig. 1 = ***Sepia officinalis*** Linné (see d'Orbigny, 1845, p. 272).

†saccoi (Sepia), Lipparini, 1934, p. 7, pl. V, fig. 2*a–b*.
sagamiana (var. of ***Sepia kobiensis*** Hoyle), Sasaki, 1929, figs. 112–114 = ***Sepia kobiensis*** var. ***andreanoides*** Hoyle, 1885 . . . . . p. 71
savignyi (Sepia), Blainville, 1827, p. 285 . . . . . p. 70
†*sepioidea* (*Sepia*) (Blainville, 1825, pars), d'Orbigny, 1845 (Pal. univ.), p. 164, pl. VIII, figs. 4–8; Férussac & d'Orbigny, 1848, p. 293, pl. 14, figs. 7–12; pl. 16, figs. 7–9 = *Beloptera sepioidea* Blainville, 1825, p. 622, pl. XI, fig. 7 = ***Belosepia sepioidea*** (see *Foss. Cat.* **1,** 11, p. 244, 1920).
†*sepioidea* (*Sepia*) (Blainville, 1825, pars), Férussac & d'Orbigny, 1835, pl. 3, fig. 5 = ***Belosepia cuvieri*** (d'Orbigny, 1824) (see *Foss. Cat.* **1,** 11, p. 243, 1920).
†*sepioidea* (*Sepia*), Nyst, 1834, p. 610 = ***Belosepia oweni*** (Sowerby, 1829) (see *Foss. Cat.* **1,** 11, p. 243, 1920).
sepiola (*Sepia*), Linné, 1758, p. 659; Gmelin, 1791, p. 1096 = ***Sepiola rondeletii*** Leach, 1817, p. 140 (see d'Orbigny, 1845, p. 301).
sepiola (*Sepia*), Lesueur, 1821, p. 100 = ***Loligopsis peronii*** Lamarck, 1812, p. 123 (see d'Orbigny, 1845, p. 301).
†sepulata (Sepia), (Michelotti) Bellardi, 1872, p. 17, pl. II, fig. 5 (see *Foss. Cat.* **1,** 11, p. 248, 1920).
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†*striatulus* (*Sepialites*), Quenstedt, 1846–1849, p. 515, pl. XXXVI, fig. 20 = ***Geoteuthis bollensis*** (v. Zieten, 1830, p. 34, pl. XXV, fig. 6) (see *Foss. Cat.* **1,** 11, p. 253, 1920).
†*striatus* (*Sepialites*), Münster, 1843, p. 76, pl. VI, fig. 6 = ***Geoteuthis bollensis*** (v. Zieten, 1830, p. 34, pl. XXV, fig. 6) (see *Foss. Cat.* **1,** 11, p. 253, 1920).
†stricta (Sepia), Bellardi, 1872, p. 17, pl. II, fig. 5 (see *Foss. Cat.* **1,** 11, p. 248, 1920).
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unguiculata (*Sepia*), Molina, 1789, p. 199 = ***Cucioteuthis unguiculatus*** (see Steenstrup, 1882, p. 153).
†*ungula* (*Sepia*), Gabb, 1861, p. 324 = ***Belosepia ungula*** (see *Foss. Cat.* **1**, 11, p. 245, 1920).
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†*venusta* (*Sepia*), Münster, 1837, p. 252 (nomen nudum); d'Orbigny, 1845 (Pal. univ.), p. 163, pl. V, fig. 7 = ***Trachyteuthis venusta*** (see *Foss. Cat.* **1**, 11, p. 250, 1920).
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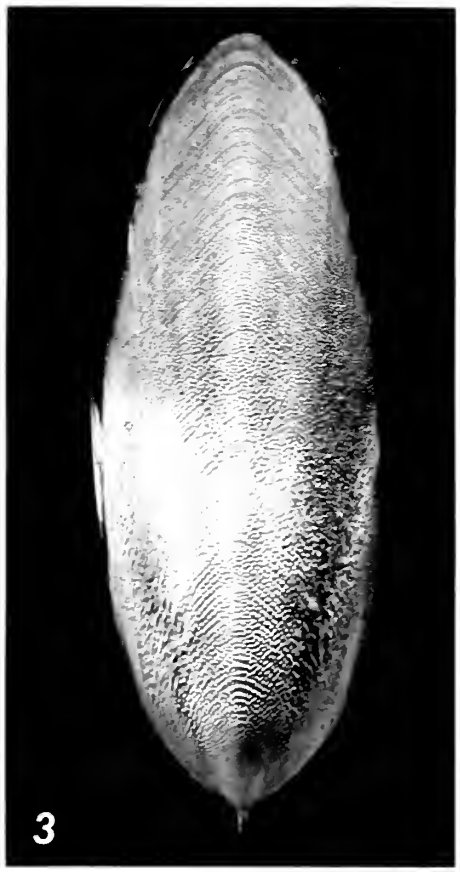
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PLATES

PLATE 1

FIGS. 1 & 2. *Sepia thurstoni* sp. nov.: Holotype, ♂; dorsal and ventral views of shell (L. = 80 mm). Madras (B.M. No. 1894.9.6.2–4).

FIGS. 3 & 4. *Sepia thurstoni* sp. nov.: Paratype, ♀; dorsal and ventral views of shell (L. = 73 mm). Negombo, Ceylon (B.M. No. 1947.5.5.36).


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PLATE 2

FIGS. 5 & 6. *Sepia brevimana* Steenstrup: ? ♂; dorsal and ventral views of shell (L. = 72 mm). Madras (B.M. No. 1952.11.24.56–58).

FIGS. 7 & 8. *Sepia brevimana* Steenstrup: ? ♀; dorsal and ventral views of shell (L. = 65 mm). Singapore (B.M. No. 1952.11.24.67).

FIGS. 9–11. *Sepia zanzibarica* Pfeffer: dorsal, ventral & lateral views of shell (L. = 184 mm). Mombasa (B.M. No. 196352W).


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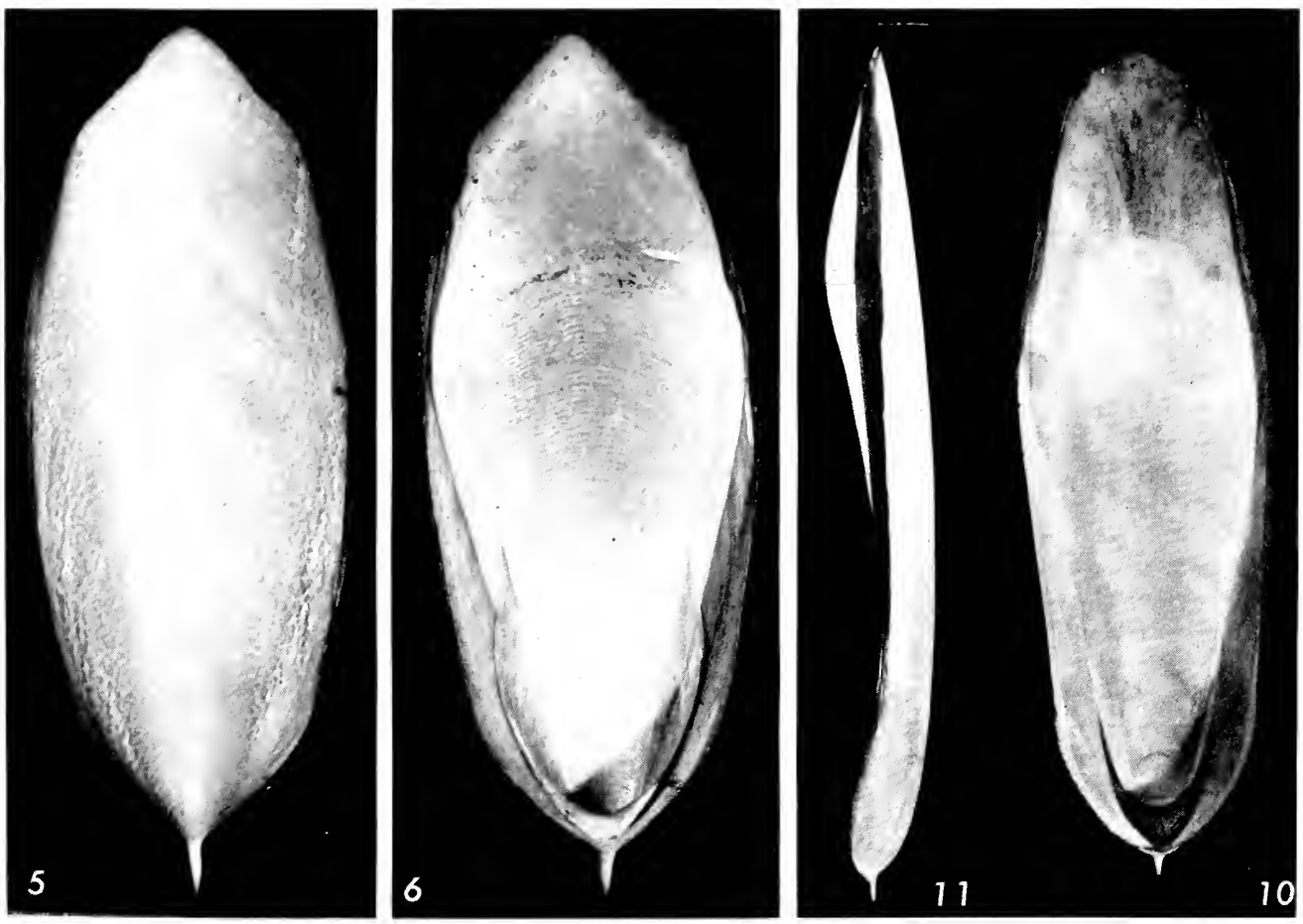
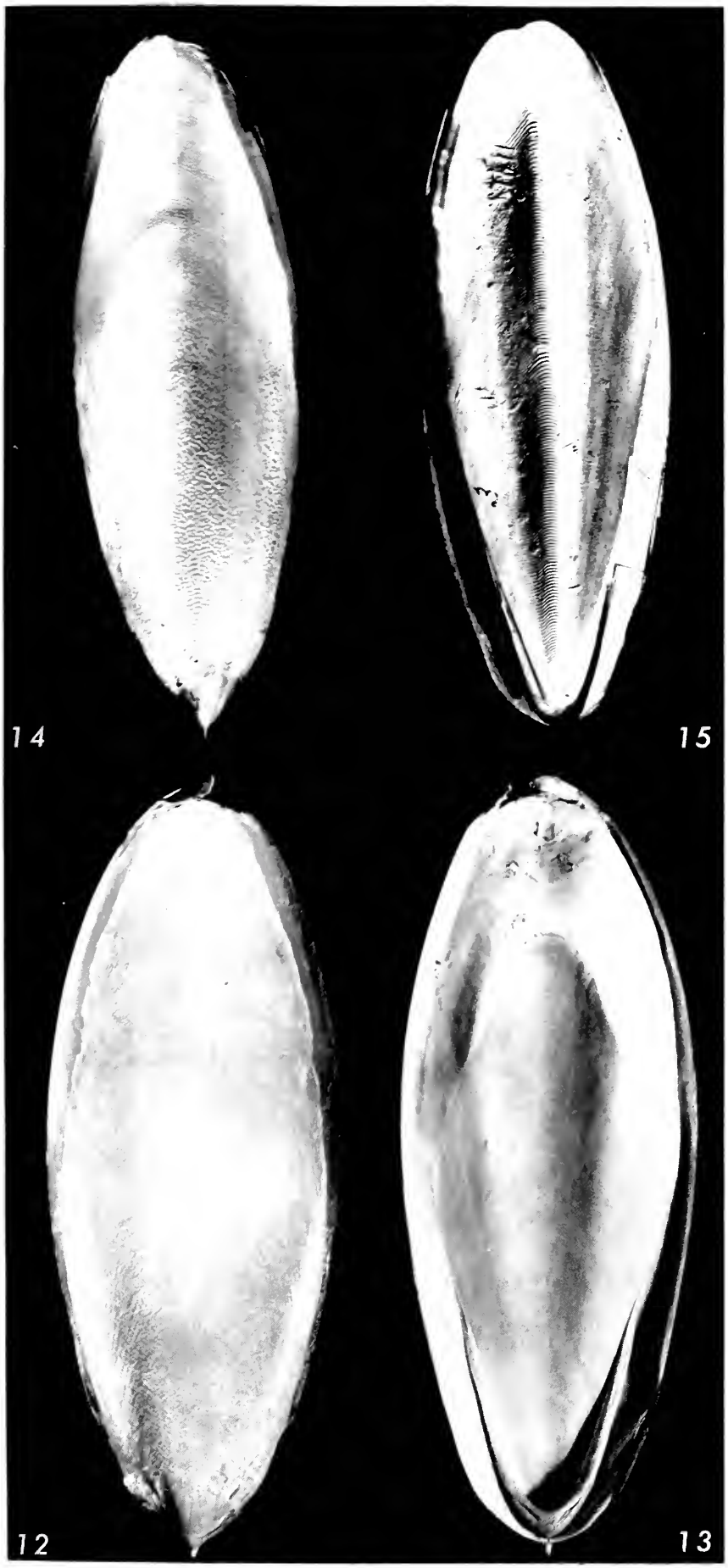

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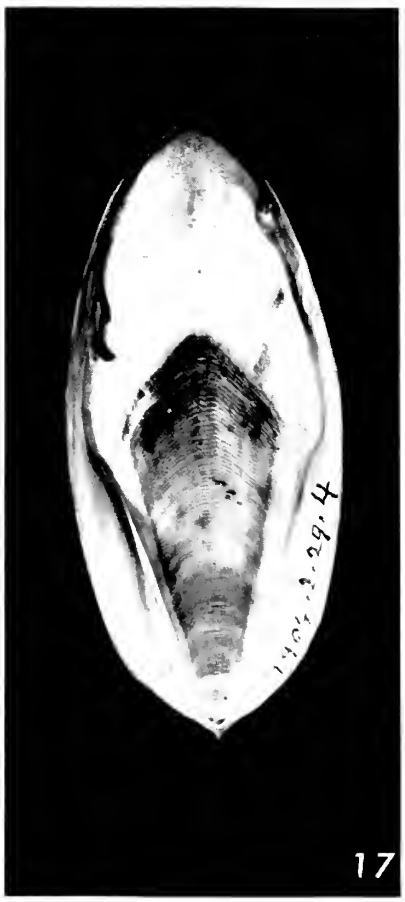
PLATE 3

FIGS. 12 & 13. *Sepia lycidas* Gray: ♀; dorsal and ventral views of shell (L. = 198 mm). China (B.M. No. 1884.2.21.17).

FIGS. 14 & 15. *Sepia lycidas* Gray: dorsal and ventral views of shell (L. = 193 mm). Sarawak, Borneo (B.M. No. 1894.7.14.5).

FIGS. 16 & 17. *Sepia savignyi* Blainville: dorsal and ventral views of shell (L. = 70 mm). Persian Gulf (B.M. No. 1904.2.29.4).


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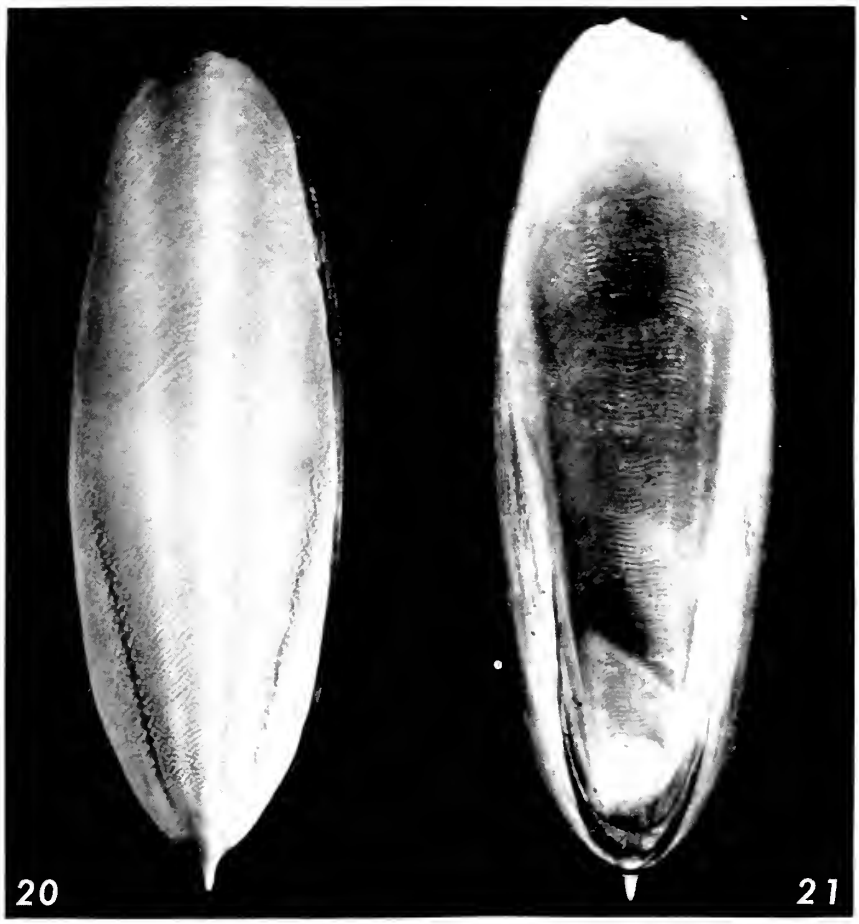

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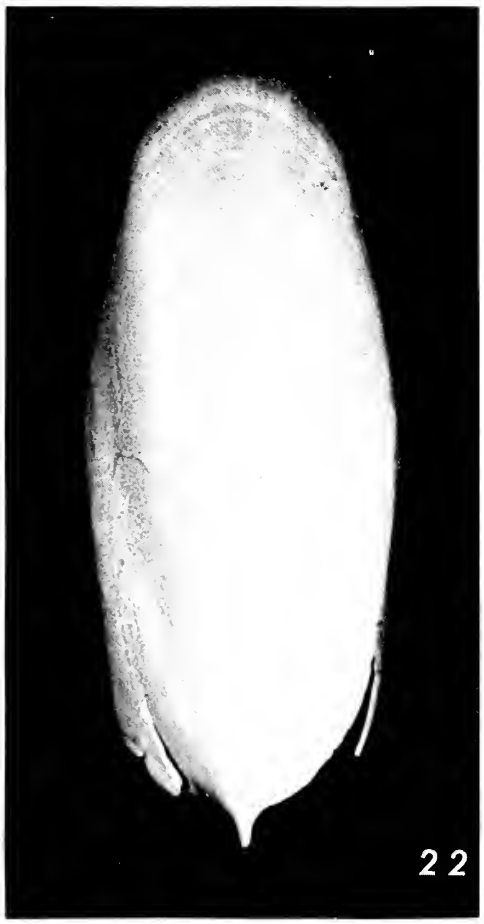
PLATE 4

FIGS. 18 & 19. *Sepia savignyi* Blainville: ♀; dorsal and ventral views of shell (L. = 88 mm). Near Cape Guardafui (John Murray Expedition, Sta. 27) (B.M. No. 196353W).

FIGS. 20 & 21. *Sepia aculeata* Férussac & d'Orbigny: ♂; dorsal and ventral views of shell (L. = 112 mm). Penang (B.M. No. 1860.6.2.86).

FIGS. 22 & 23. *Sepia prionota* Voss: Paratype, ♀; dorsal and ventral views of shell (L. = 36 mm). Off Sirun Island, Sulu Archipelago (Smithsonian Institution).


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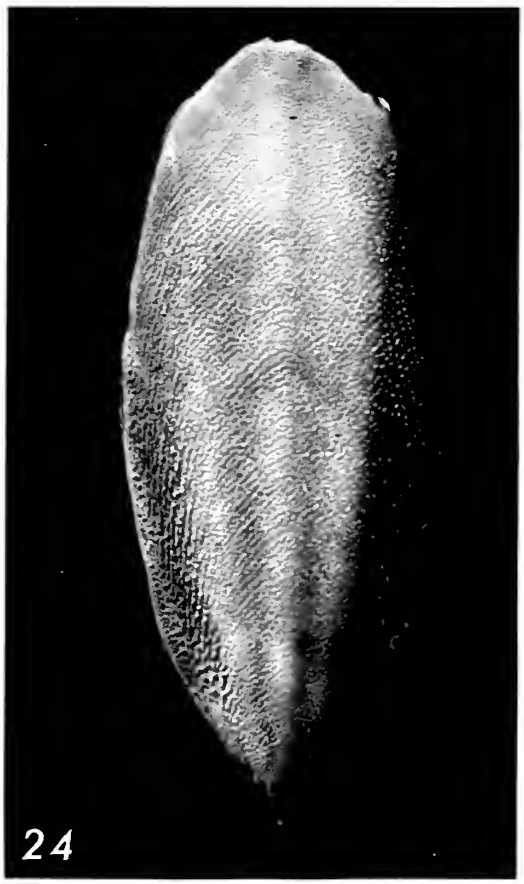

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PLATE 5

FIGS. 24 & 25. *Sepia elliptica* Hoyle: Syntype, ♂: dorsal and ventral views of shell (L. = 72 mm). *Challenger* Sta. 190, Arafura Sea (B.M. No. 1889.4.24.73).

FIGS. 26 & 27. *Sepia elliptica* Hoyle: Syntype, ♀; dorsal and ventral views of shell (L. = 54 mm). *Challenger* Sta. 190, Arafura Sea (B.M. No. 1889.4.24.74).


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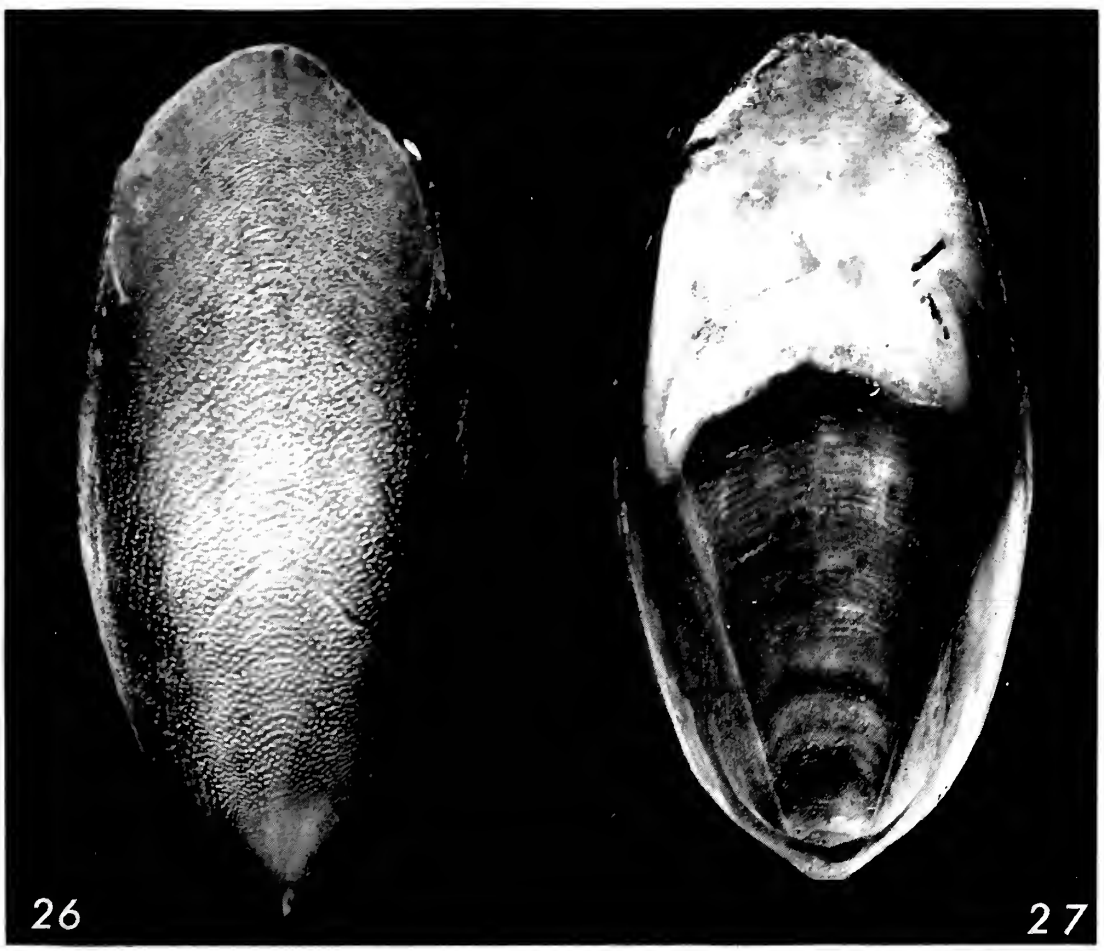

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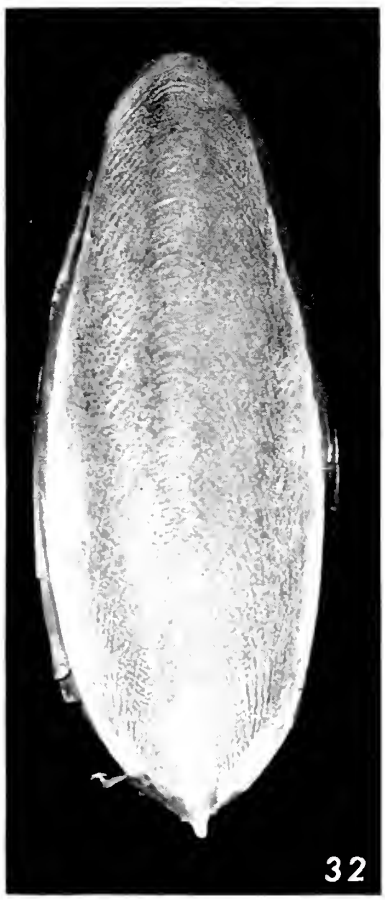
PLATE 6

FIGS. 28 & 29. *Sepia whitleyana* (Iredale): dorsal and ventral views of shell (L. = 89 mm). Caloundra, Queensland (B.M. No. 1962255W).

FIGS. 30 & 31. *Sepia esculenta* Hoyle: Syntype, ♂; dorsal and ventral views of shell (L. = 158 mm). Yokohama Market, Japan (B.M. No. 1889.4.24.69).

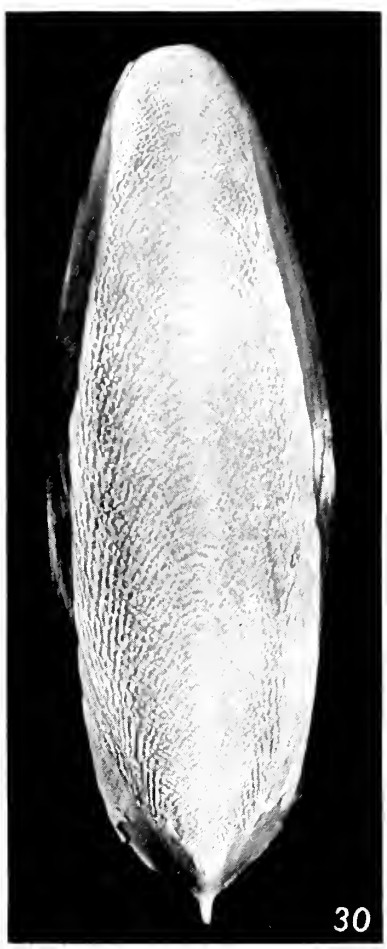
FIGS. 32 & 33 *Sepia esculenta* Hoyle: Syntype ♀; dorsal and ventral views of shell (L. = 142 mm). Yokohama Market, Japan (B.M. No. 1889.4.24.70).


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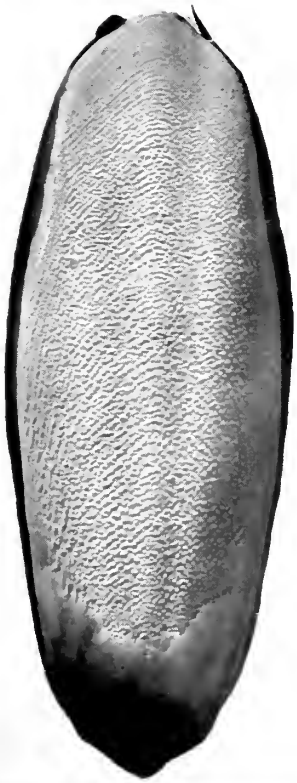

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PLATE 7

FIGS. 34 & 35. *Sepia smithi* Hoyle: Syntype, ♀: dorsal and ventral views of shell (L. = 81 mm). *Challenger* Sta. 188, Arafura Sea (B.M. No. 1889.4.24. 66–67).

FIGS. 36 & 37. *Sepia pageora* (Iredale): ♂; dorsal and ventral views of shell (L. = 90 mm). Cape Upstart, Australia (B.M. No. 1963118W).



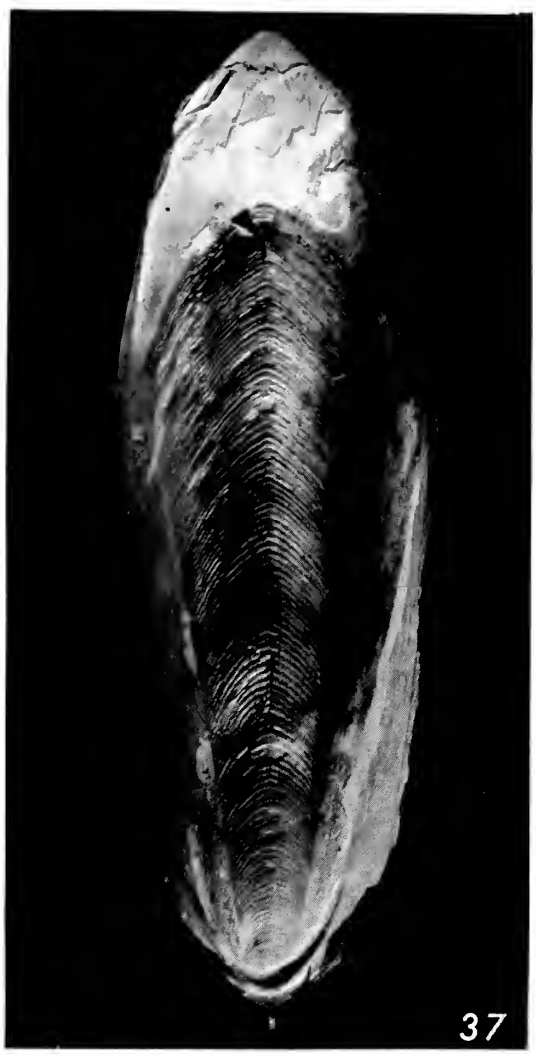
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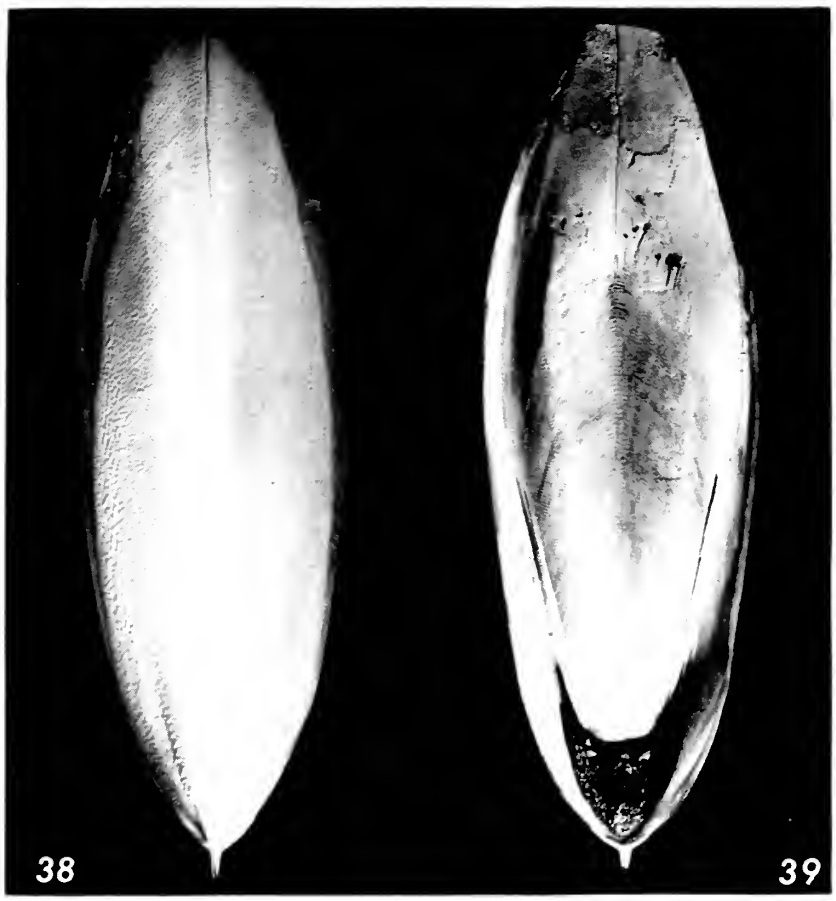
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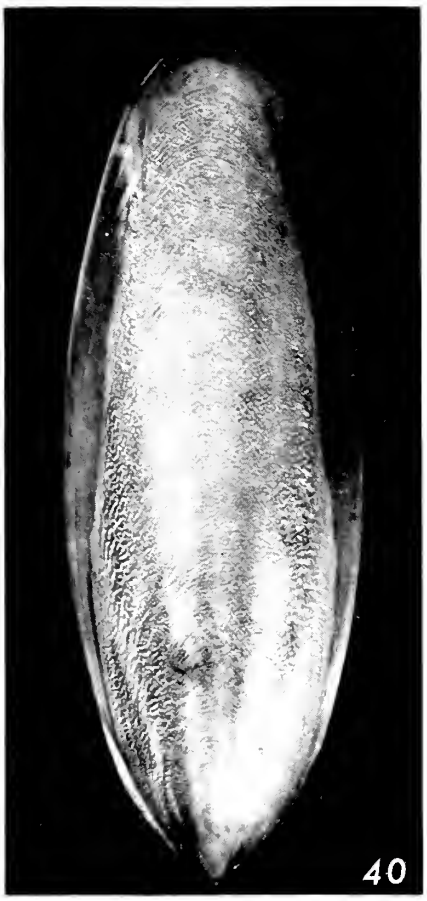
PLATE 8

FIGS. 38 & 39. *Sepia pharaonis* Ehrenberg: ♂?; dorsal and ventral views of shell (L. = 150 mm). Trincomali (B.M. No. 1952.11.21.27).

FIGS. 40 & 41. *Sepia pharaonis* Ehrenberg: ♀; dorsal and ventral views of shell (L. = 153 mm). Ennûr (B.M. No. 1952.11.24.8).

FIGS. 42 & 43. *Sepia pharaonis* Ehrenberg: dorsal and ventral views of shell (L. = 168+ mm). Cottesloe, W. Australia (B.M. No. 196226oW).


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PLATE 9

FIGS. 44 & 45. *Sepia prashadi* Winckworth: ♂; dorsal and ventral views of shell (L. = 88 mm). John Murray Expedition, Sta. 75, Gulf of Oman (B.M. No. 196365W).

FIGS. 46–48. *Sepia prashadi* Winckworth: ♀; dorsal, ventral and lateral views of shell (L. = 120 mm). See data as for Figs. 44 & 45.

FIGS. 49 & 50. *Sepia recurvirostra* Steenstrup: ♂; dorsal and ventral views of shell (L. = 60 mm). Singapore fish market (B.M. No. 1947.5.16.2).

FIGS. 51 & 52. *Sepia recurvirostra* Steenstrup: ?♂; dorsal and ventral views of shell (L. = 45 mm). Singapore (B.M. No. 1952.11.24.93).

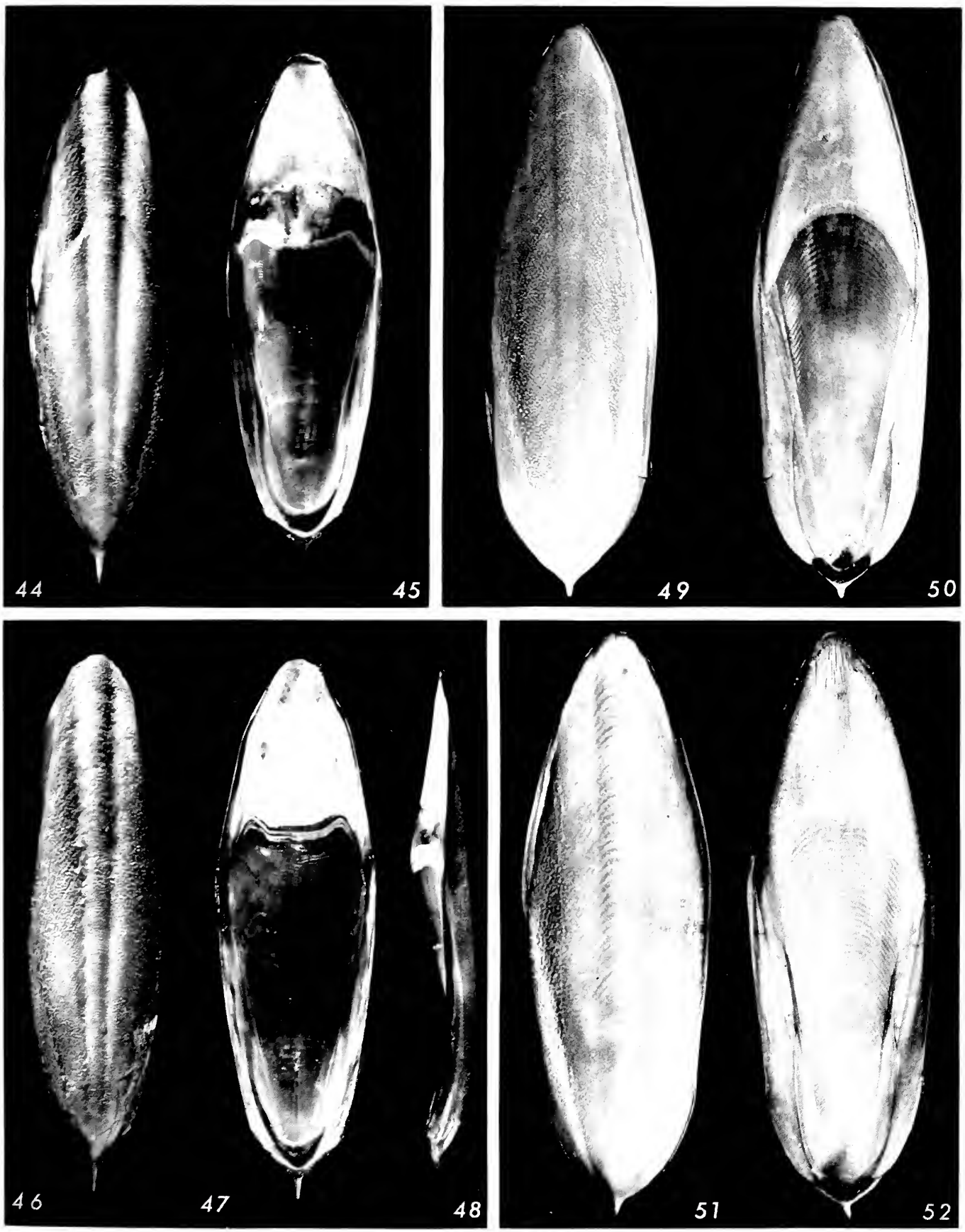

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PLATE 10

FIGS. 53 & 54. *Sepia recurvirostra* Steenstrup: ♂; dorsal and ventral views of shell (L. = 71 mm). N. China (B.M. No. 1863.5.1.6).

FIGS. 55 & 56. *Sepia officinalis vermiculata* Quoy & Gaimard: dorsal and ventral views of shell (L. = 115 mm). Isipingo, S. Africa (B.M. No. 1952.11.24.80).


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PLATE 11

FIGS. 57 & 58. *Sepia officinalis hierredda* Rang: ♂; dorsal and ventral views of shell (L. = 320 mm). From 15°57′S., 11°40′E. (I.R.S.N. Bruxelles).

FIGS. 59 & 60. *Sepia officinalis hierredda* Rang: ♀; dorsal and ventral views of shell (L. = 268 mm). Data as for Figs. 57 & 58.

FIGS. 61 & 62. *Sepia latimanus* Quoy & Gaimard: ♀; dorsal and ventral views of shell (L. = 260 mm). Singapore fish market (B.M. No. 1947.5.16.1).

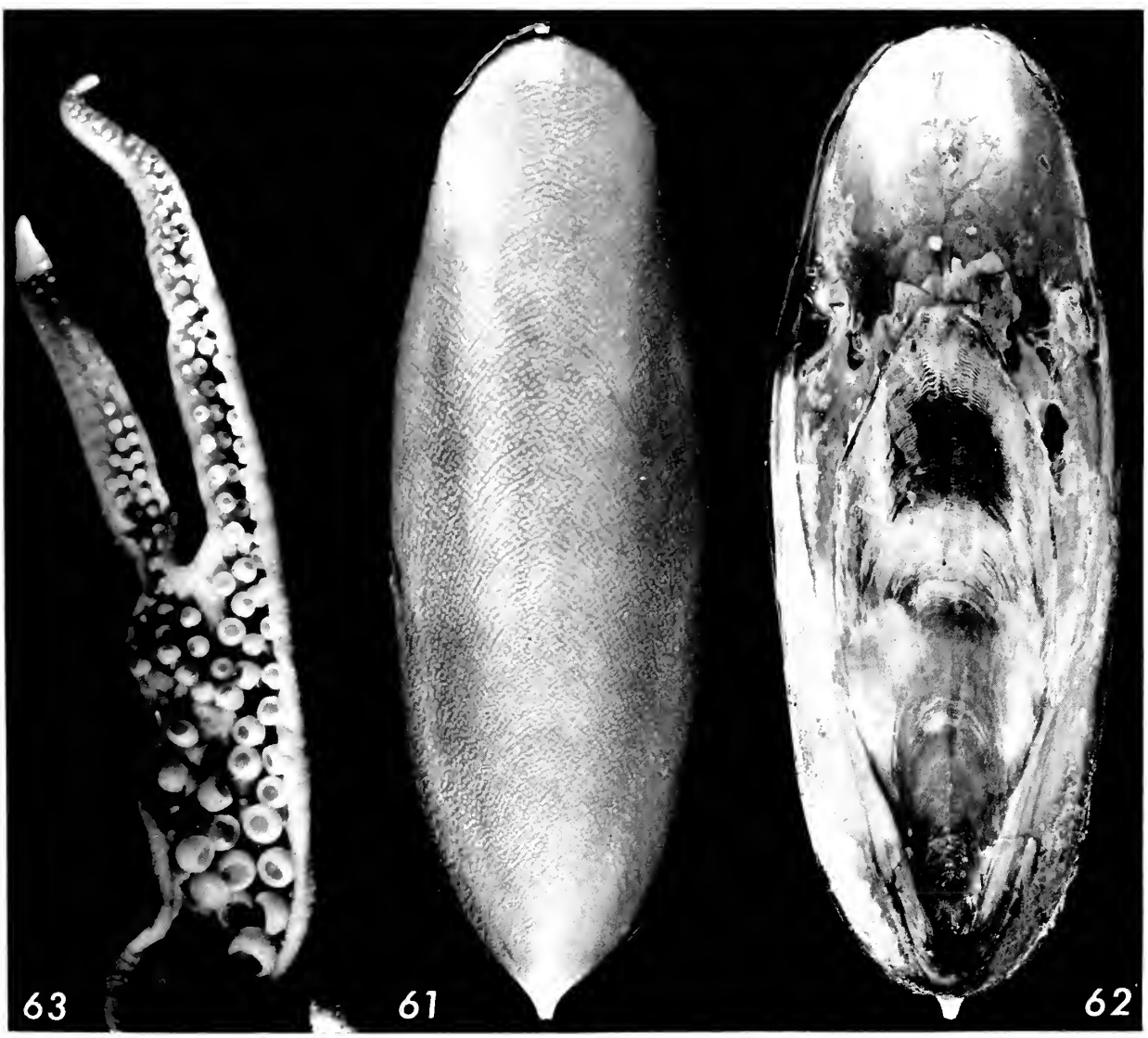
FIG. 63. *Sepia latimanus* Quoy & Gaimard: ♀. Abnormal right ventral arm (distal 4 cm). Data as for Figs. 61 & 62.


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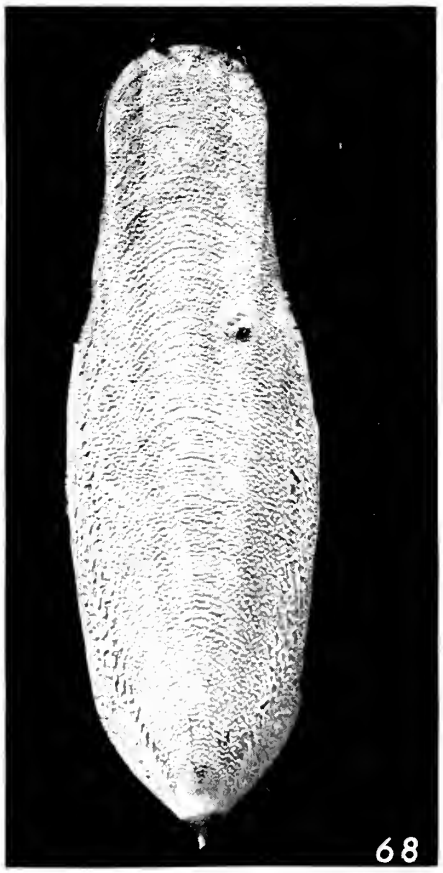
PLATE 12

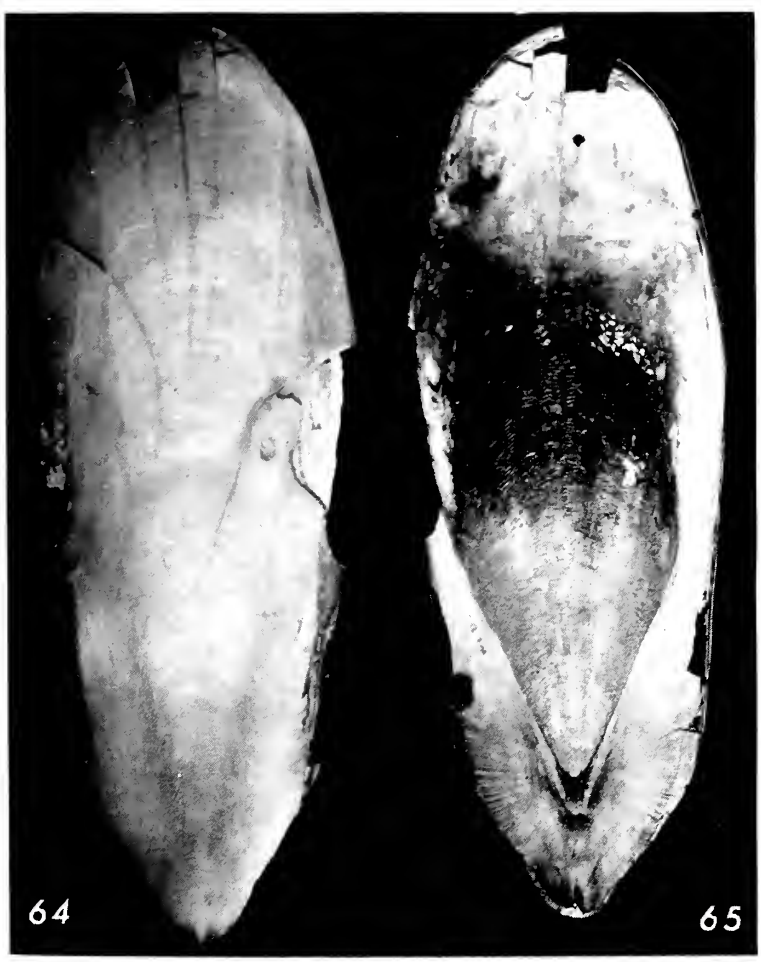
FIGS. 64 & 65. *Sepia apama* Gray: ♀; dorsal and ventral views of shell (L. = 300 mm). Cobblers Beach, Port Jackson (B.M. No. 1890.6.21.1).

FIGS. 66 & 67. *Sepia apama* Gray: dorsal and ventral views of shell (L. = 97 mm). Semaphore, South Australia (B.M. No. 1962259W).

FIGS. 68 & 69. *Sepia papuensis* Hoyle: Syntype, ♂; dorsal and ventral views of shell (L. = 63 mm). *Challenger* Sta. 188, Arafura Sea (B.M. No. 1889.4.24.68).


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PLATE 13

FIGS. 70 & 71. *Sepia plangon* Gray: ♀; dorsal and ventral views of shell (L. = 69 mm). Port Jackson, Australia (Admiralty) (B.M. No. 196375W).

FIGS. 72 & 73. *Sepia plangon* Gray: dorsal and ventral views of shell (L. = 83 mm). Caloundra, Queensland (B.M. No. 1915.8.28.1).

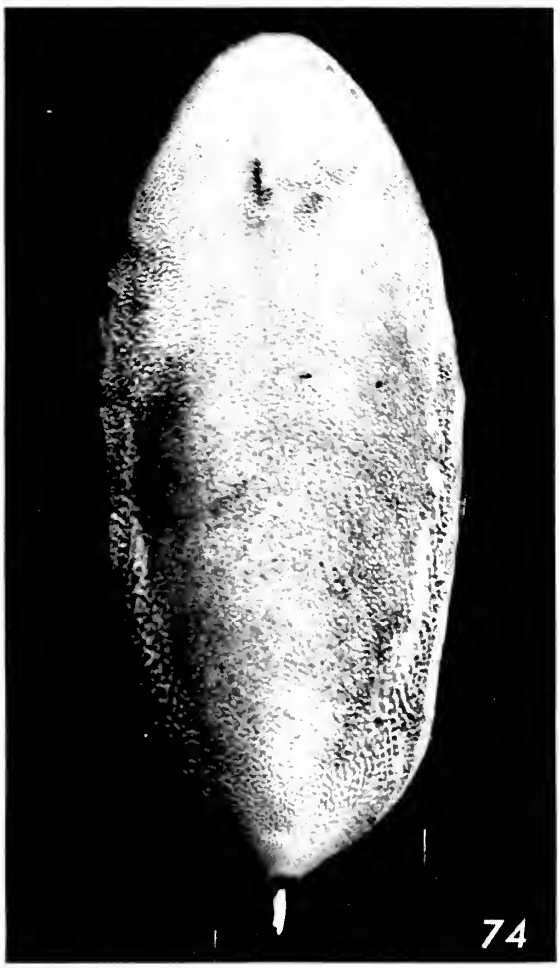
FIGS. 74 & 75. *Sepia mestus* Gray: ♀; dorsal and ventral views of shell (L. = 46·5 mm). N. China (B.M. No. 1863.5.1.6).



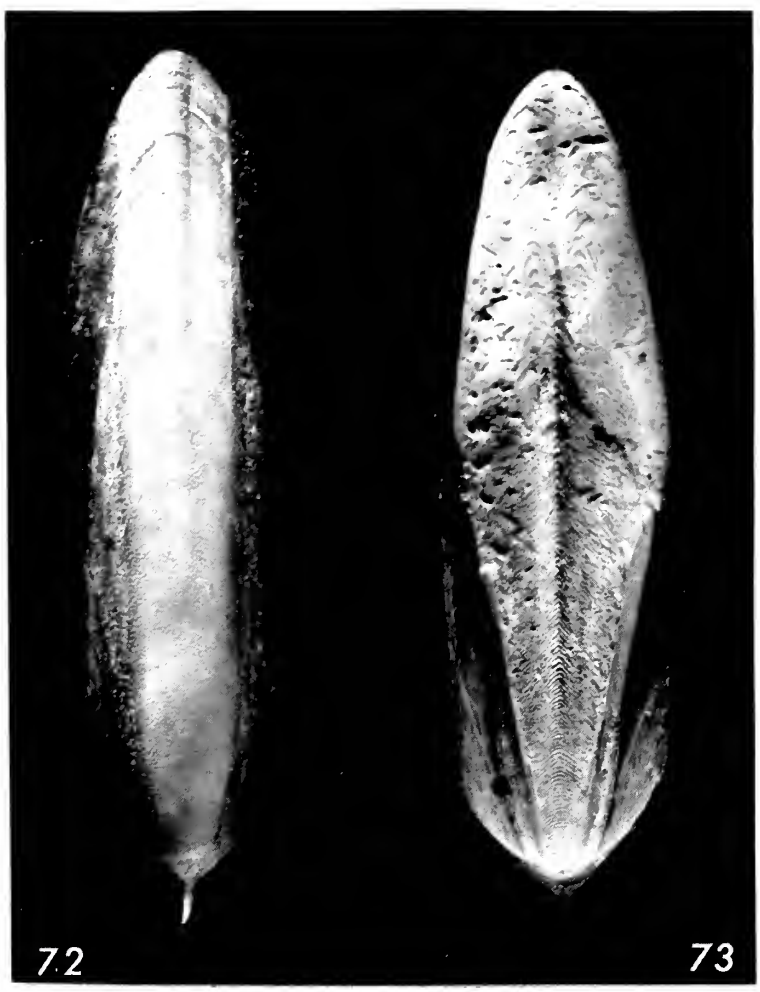
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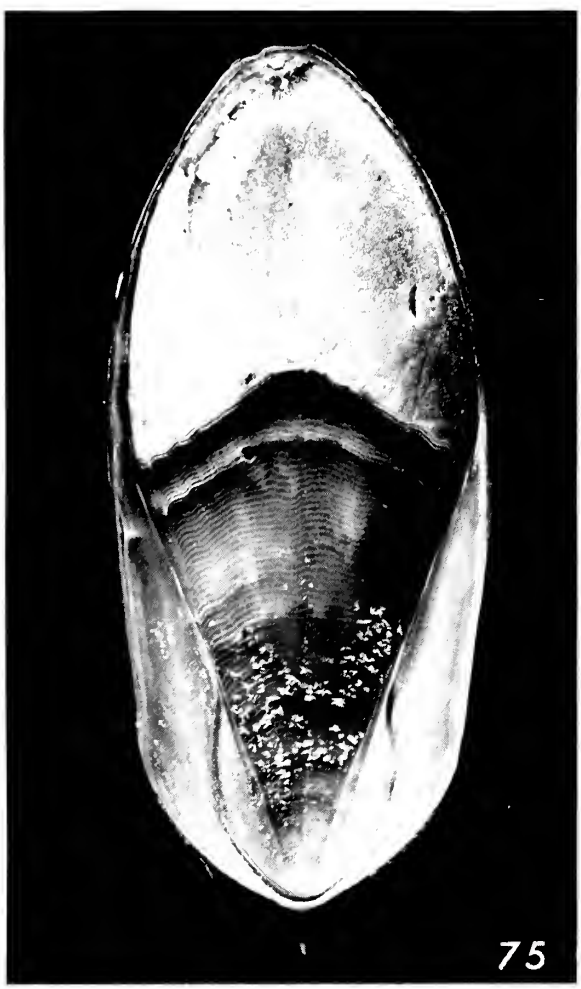
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PLATE 14

FIGS. 76 & 77. *Sepia mestus* Gray: Syntype; dorsal and ventral views of shell (L. = 51 mm) Australia (B.M. No. 1842.11.9.54).

FIGS. 78 & 79. *Sepia mestus* Gray: dorsal and ventral views of shell (L. = 91 mm). Caloundra, Queensland (B.M. No. 1915.8.28.2–3).


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PLATE 15

FIGS. 80 & 81. *Sepia mestus* Gray: dorsal and ventral views of shell (L. = 64 mm). Caloundra, Queensland (B.M. No. 1915.8.28.2–3).

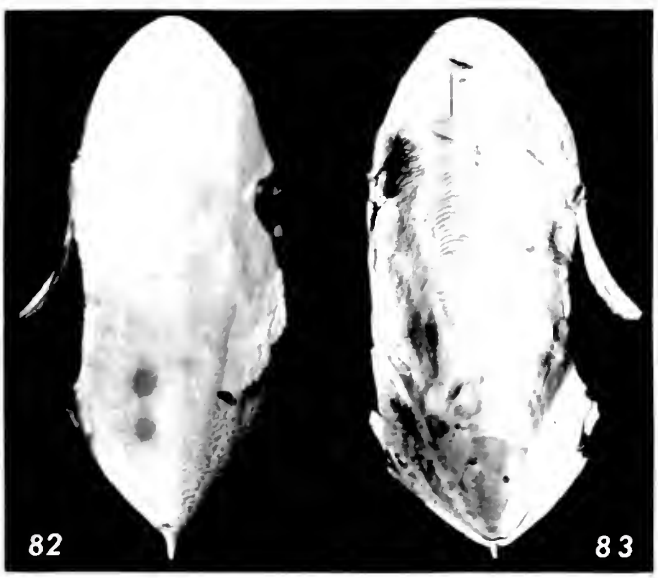
FIGS. 82 & 83. *Sepia mestus* Gray: Holotype of *Ascarosepion verreauxi* Rochebrune; dorsal and ventral views of shell (L. = 137 mm). Sydney (Mus. nat. Hist. nat. Paris).

FIGS. 84–86. *Sepia novaehollandiae* Hoyle: dorsal and ventral views of three shells (L. = 42, 47 and 48 mm). Adelaide (B.M. No. 1890.3.24.280–2).

FIGS. 87 & 88. *Sepia novaehollandiae* Hoyle: ? ♀; dorsal and ventral views of shell (L. = 122 mm). Semaphore, South Australia (B.M. No. 1962256W/1).

FIGS. 89 & 90. *Sepia novaehollandiae* Hoyle: ? ♂; dorsal and ventral views of shell (L. = 122 mm). Semaphore, S. Australia (B.M. No. 1962256W/2).


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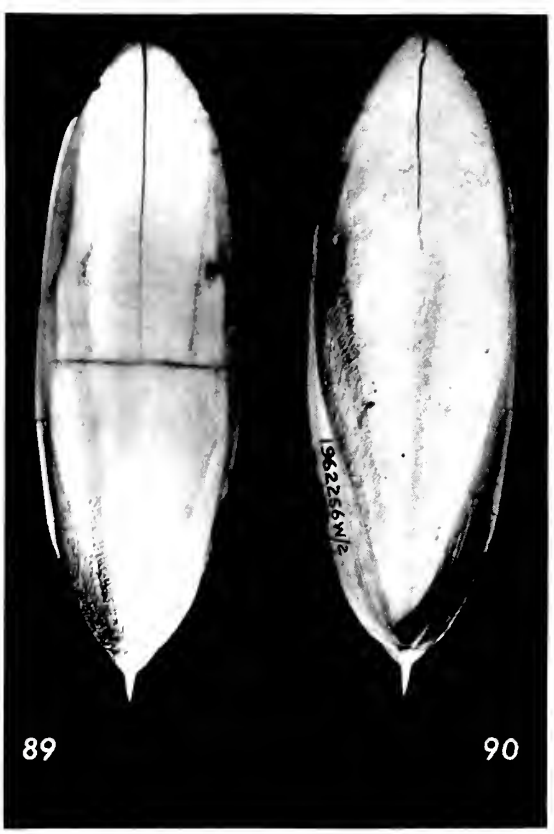

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PLATE 16

FIGS. 91 & 92. *Sepia acuminata* Smith: Syntype; dorsal and ventral views of shell (L. = 104 mm). Port Elizabeth, South Africa (B.M. No. 1890.9.22.332–3).

FIGS. 93 & 94. *Sepia jaenschi* (Cotton): dorsal and ventral views of shell (L. = 112 mm). Robe, South Australia (B.M. No. 1962258W).

FIGS. 95 & 96. *Sepia bertheloti* d'Orbigny: ♂; dorsal and ventral views of shell (L. = 170 mm). From 6°18′S., 11°54′E. (I.R.S.N., Bruxelles).

FIGS. 97 & 98. *Sepia bertheloti* d'Orbigny: ♀; dorsal and ventral views of shell (L. = 130 mm). From 7°16′S., 12°17′E. (I.R.S.N., Bruxelles).


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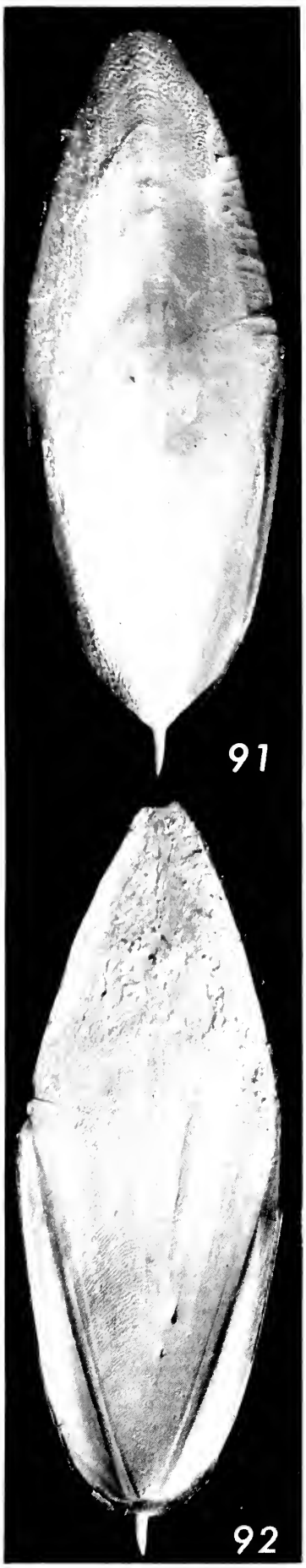

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PLATE 17

FIGS. 99 & 100. *Sepia cultrata* Hoyle: dorsal and ventral views of shell (L. = 85 mm). Sydney, Australia (B.M. No. 1837.5.13.44).

FIGS. 101–103. *Sepia appellöfi* Wülker: ♀; dorsal, ventral and lateral views of shell (L. = 90 mm). Sagami Bay, Japan (B.M. No. 1910.9.29.1).

FIGS. 104–106. *Sepia sewelli* sp. nov.: Paratype; dorsal, ventral and lateral views of shell (L. = 31 mm). John Murray Expedition, Sta. 106, 5°38′54″S., 39°15′42″E. to 5°40′18″S., 39°17′36″E. (B.M. No. 196380W).

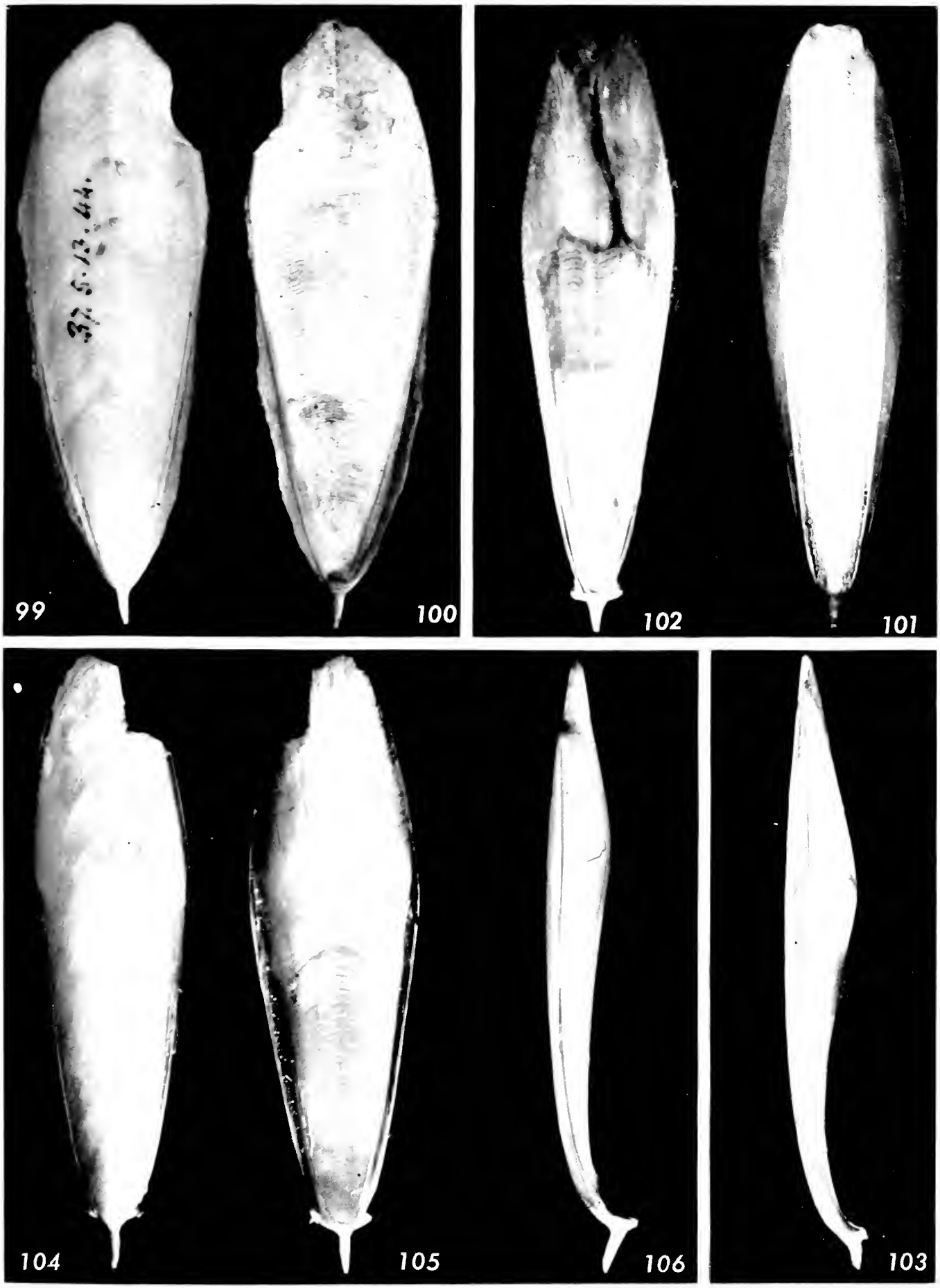
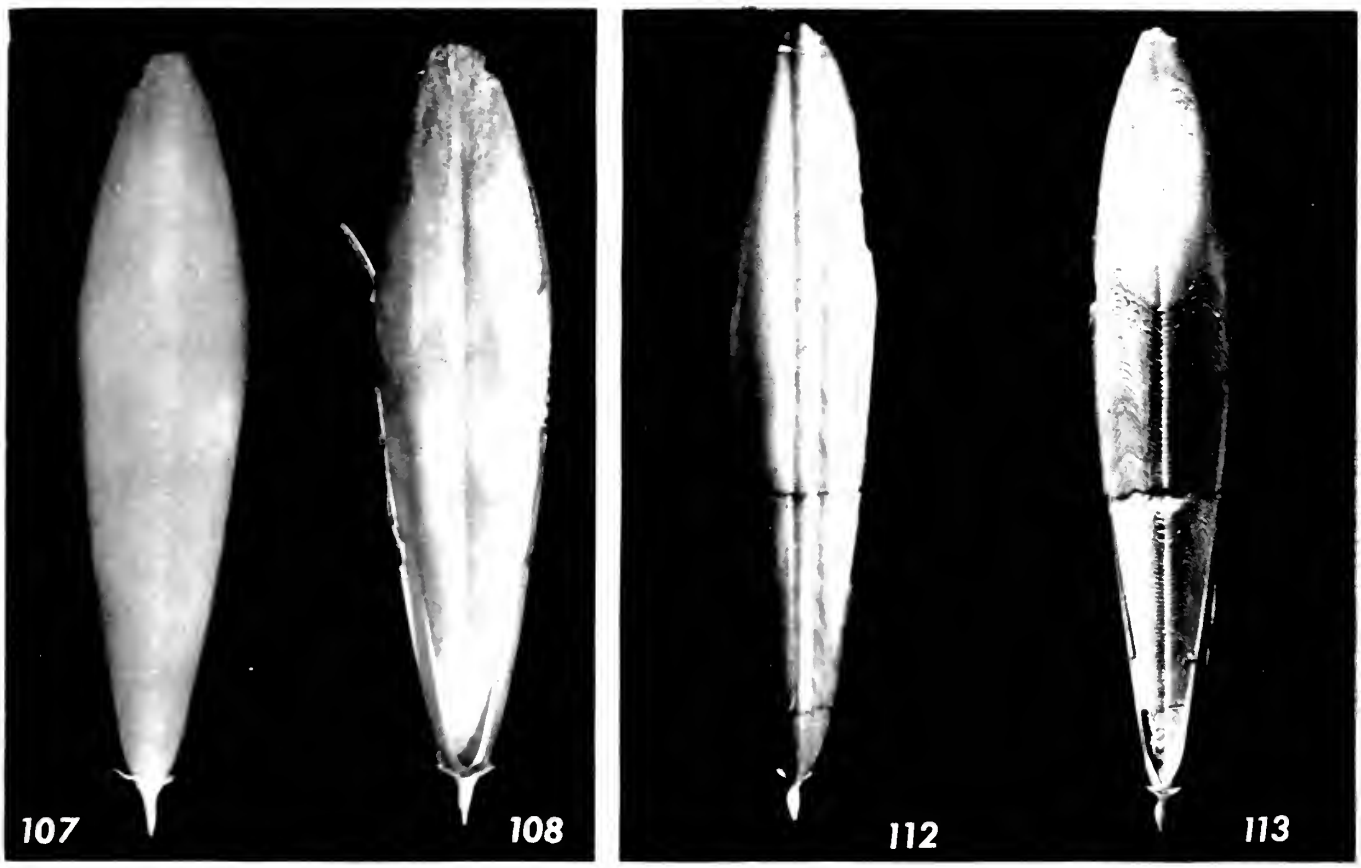

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PLATE 18

FIGS. 107–109. *Sepia murrayi* sp. nov.: Holotype, ♀; dorsal, ventral and lateral views of shell (L. = 40 mm). John Murray Expedition, Sta. 71, Gulf of Oman (B.M. No. 196381W).

FIGS. 110 & 111. *Sepia murrayi* sp. nov.: Paratype, ♀; dorsal and ventral views of whole animal (dorsal mantle-length, 40 mm). John Murray Expedition, Sta. 71 (B.M.No. 196382W).

FIGS. 112 & 113. *Sepia confusa* Smith; ♀; dorsal and ventral views of shell (L. = 84 mm). John Murray Expedition, Sta. 106, 5°38′54″S., 39°15′42″E. to 5°40′18″S., 39°17′36″E. (B.M. No. 196384W).


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PLATE 19

FIGS. 114 & 115. *Sepia incerta* Smith: Syntype; dorsal and ventral views of imperfect shell (L. = 119+mm). Port Elizabeth, S. Africa (B.M. No. 1890.12.14.43–44).

FIGS. 116 & 117. *Sepia kobiensis* Hoyle: Holotype, ♀; dorsal and ventral views of shell (L. = 40·5+ mm). *Challenger* Sta. 233, Bay of Kobe, Japan (B.M. No. 1889.4.24.81).

FIGS. 118–120. *Sepia kobiensis* Hoyle: Syntype (? ♀) of *S. andreanoides* Hoyle; dorsal, ventral and lateral views of shell (L. = 60 mm). Yokohama Market, Japan (B.M. No. 1889.4.24.78).

FIGS. 121–123. *Sepia braggi* Verco: dorsal, ventral and lateral views of shell (L. = 56 mm). Adelaide, South Australia (B.M. No. 1952.11.24.34–36).

FIGS. 124–126. *Sepia braggi* Verco: dorsal, ventral and lateral views of shell (L. = 36 mm). Adelaide, S. Australia (B.M. No. 1952.11.24.34–36).

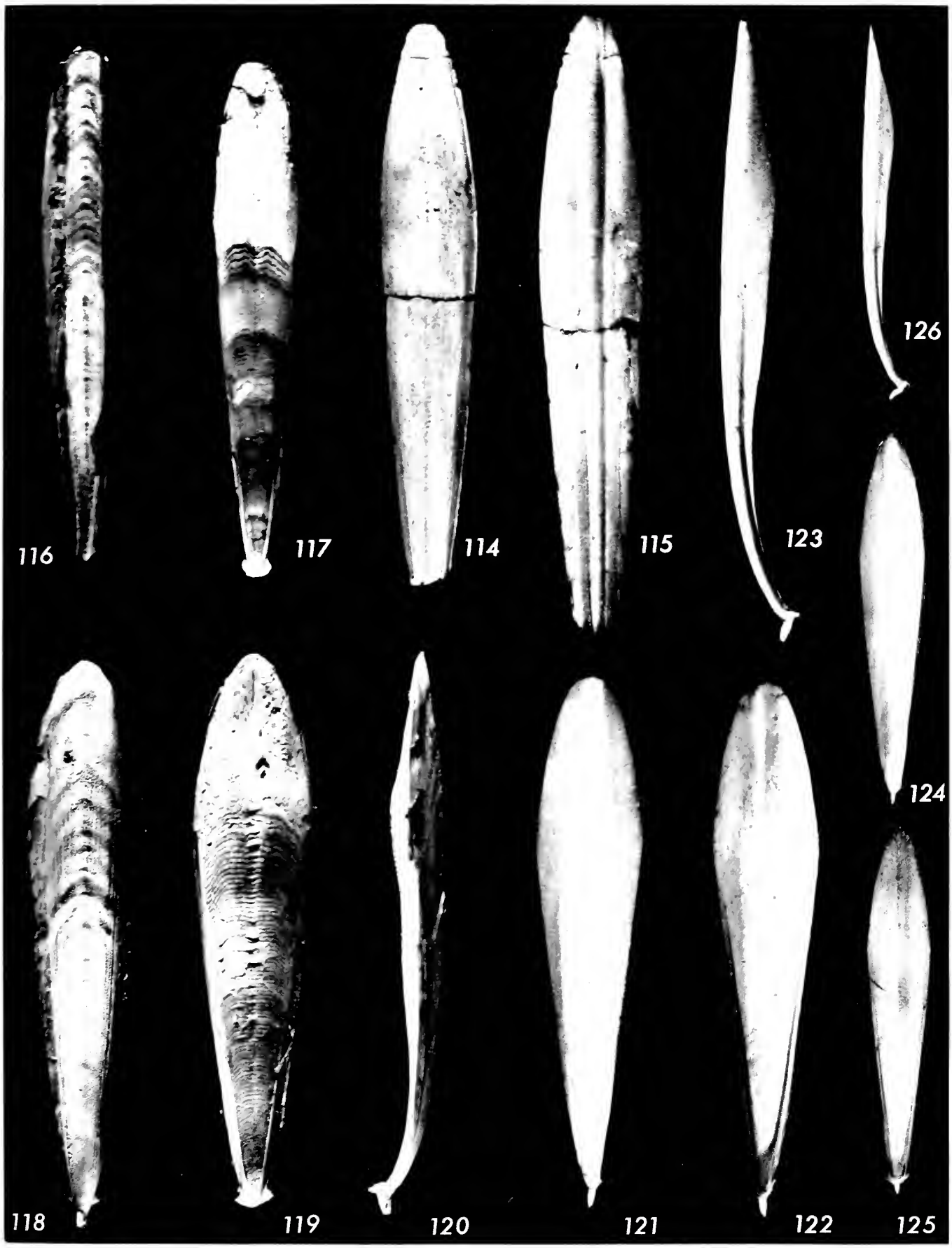

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PLATE 20

FIGS. 127–128. *Sepia burnupi* Hoyle: dorsal and ventral views of shell (L. = 45 mm). Umkomaas, Natal (B.M. No. 1904.2.13.5).

FIGS. 129–131. *Sepia trygonina* (Rochebrune): ♀; dorsal, ventral and lateral views of shell (L. = 50 mm). John Murray Expedition, Sta. 27, near Cape Guardafui (B.M. No. 196388–94W).

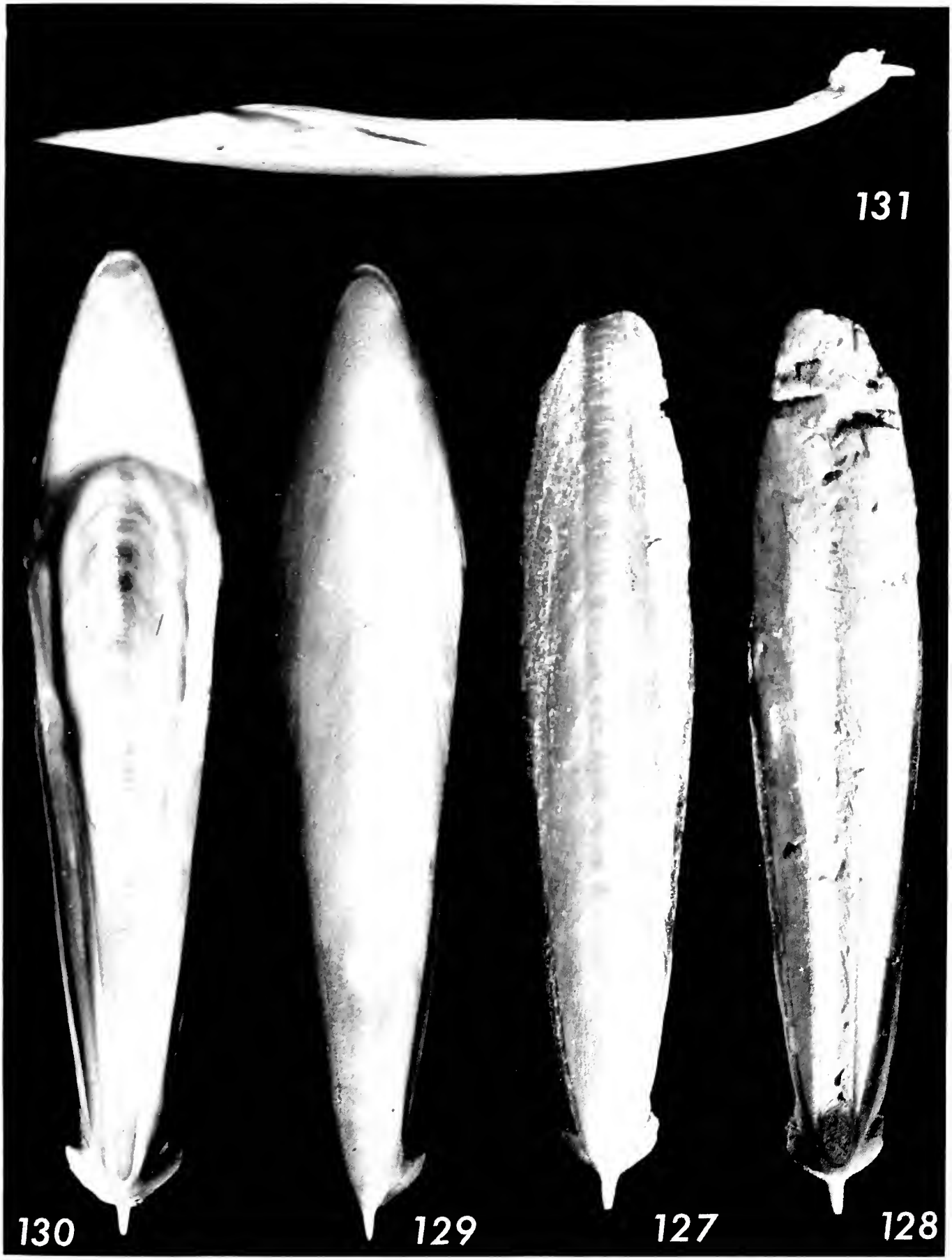

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PLATE 21

FIGS. 132 & 133. *Sepia elongata* d'Orbigny: Holotype; dorsal and ventral views of shell (L. = 48·5+ mm). Near Cosseir, Red Sea (Mus. nat. Hist. nat. Paris).

FIGS. 134 & 135. *Sepia orbignyana* Férussac: ♂; dorsal and ventral views of shell (L. = 86 mm). African coast, S. Atlantic (I.R.S.N.).

FIGS. 136 & 137. *Sepia orbignyana* Férussac: ♀; dorsal and ventral views (L. = 83 mm). Position, 6°29′S., 11°35′E. (I.R.S.N.).

FIGS. 138–140. *Sepia australis* Quoy and Gaimard: dorsal, ventral and lateral views of shell (L. = 56·5 mm). Grahamstown, Natal (B.M. No. 1952.11.21.31).

FIGS. 141 & 142. *Sepia australis* Quoy & Gaimard: Holotype of *S. sinope* Gray; dorsal and ventral views of shell (L. = 44+mm). ? China (B.M. No. 196385W).

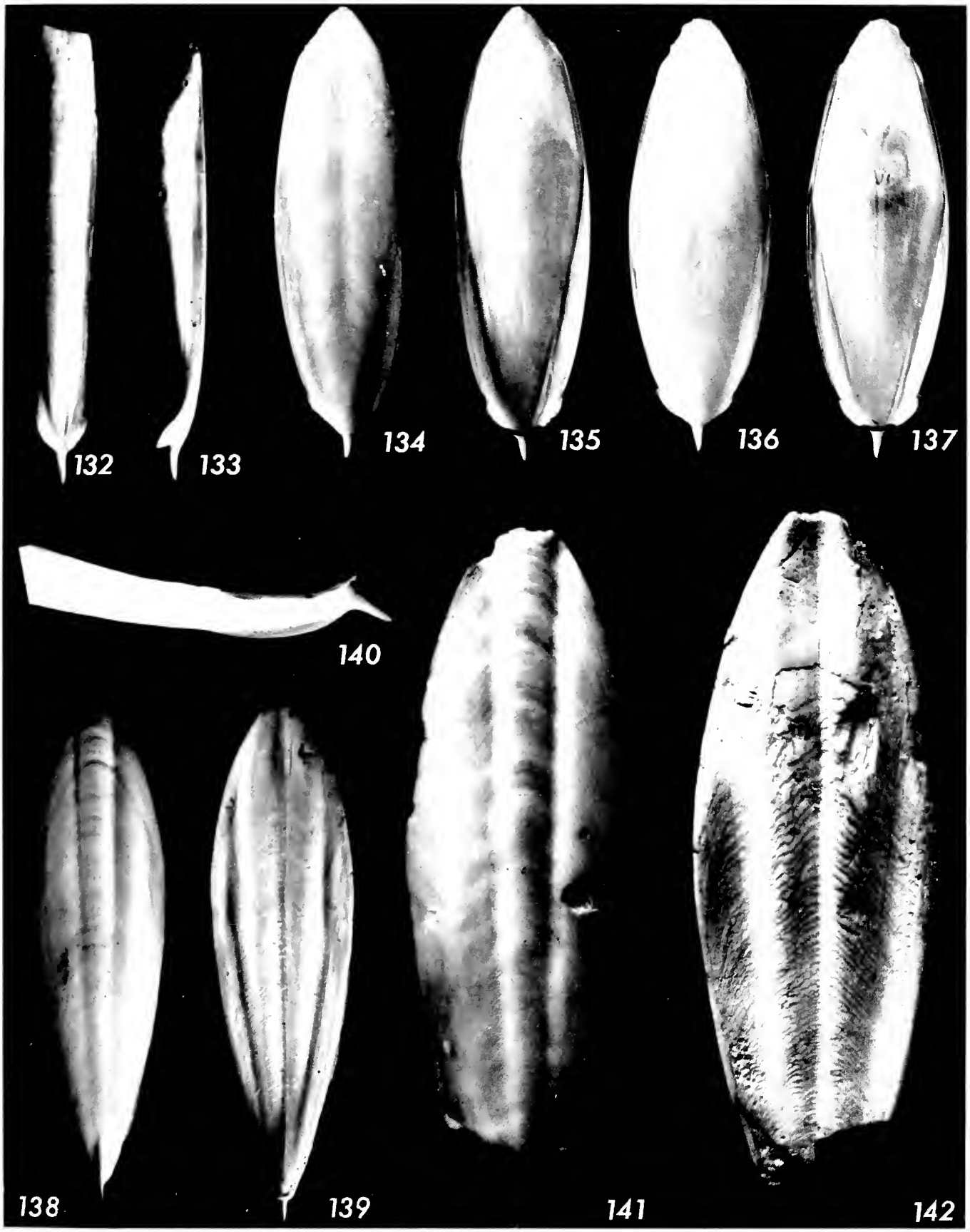

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PLATE 22

FIGS. 143–145. *Sepia omani* sp. nov: Holotype, ♂; dorsal, ventral and lateral views of shell (L. = 62 mm). John Murray Expedition, Sta. 75, Gulf of Oman (B.M. No. 1963107W).

FIG. 146 & 147. *Sepia omani* sp. nov.: Paratype, ♀; dorsal and ventral views of posterior end of shell (Length of whole shell, 53 mm). John Murray Expedition, Sta. 75, Gulf of Oman (B.M. No. 1963108–114W).

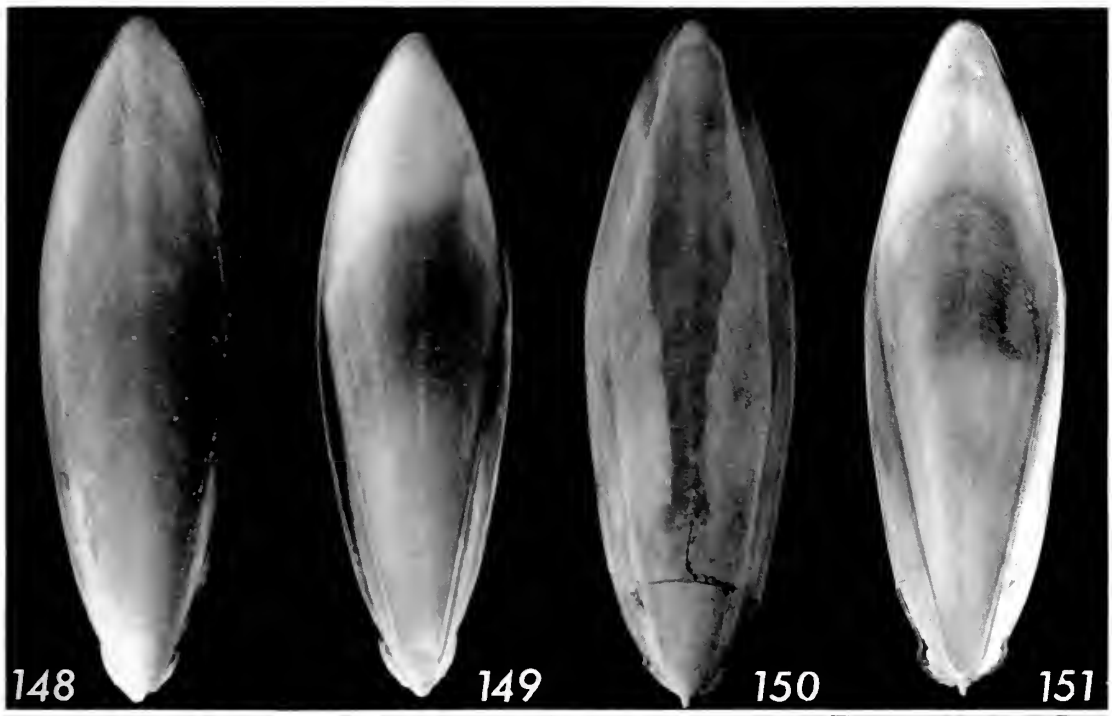

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PLATE 23

FIGS. 148 & 149. *Sepia elegans* Blainville: ♂; dorsal and ventral views of shell (L. = 54 mm). Position, 0°S., 8°58′E. (I.R.S.N.).

FIGS. 150 & 151. *Sepia elegans* Blainville: ♀; dorsal and ventral views of shell (L. = 77·5 mm). Position, 6°18′S., 11°34′E. (I.R.S.N.).

FIGS. 152–155. *Sepia arabica* Massy: ♂; dorsal, ventral, lateral and enlarged posterior ventral views of shell (L. = 65 mm). John Murray Expedition, Sta. 194, Gulf of Aden (B.M. No. 196386W).


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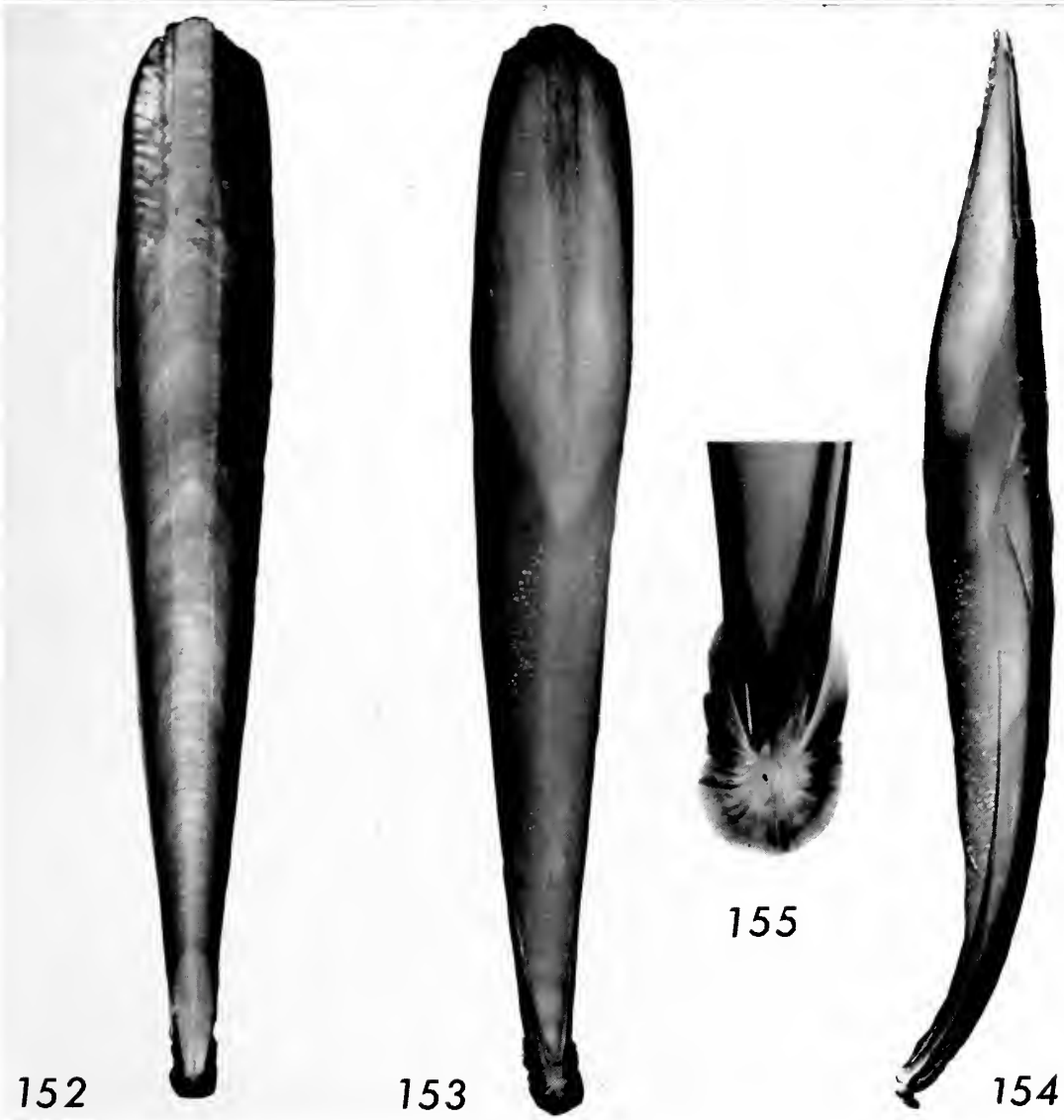

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PLATE 24

FIGS. 156–158. *Sepia dollfusi* Adam: ♂; dorsal, ventral and lateral views (L. = 48 mm). Suez (B.M. No. 1926.4.8.1).

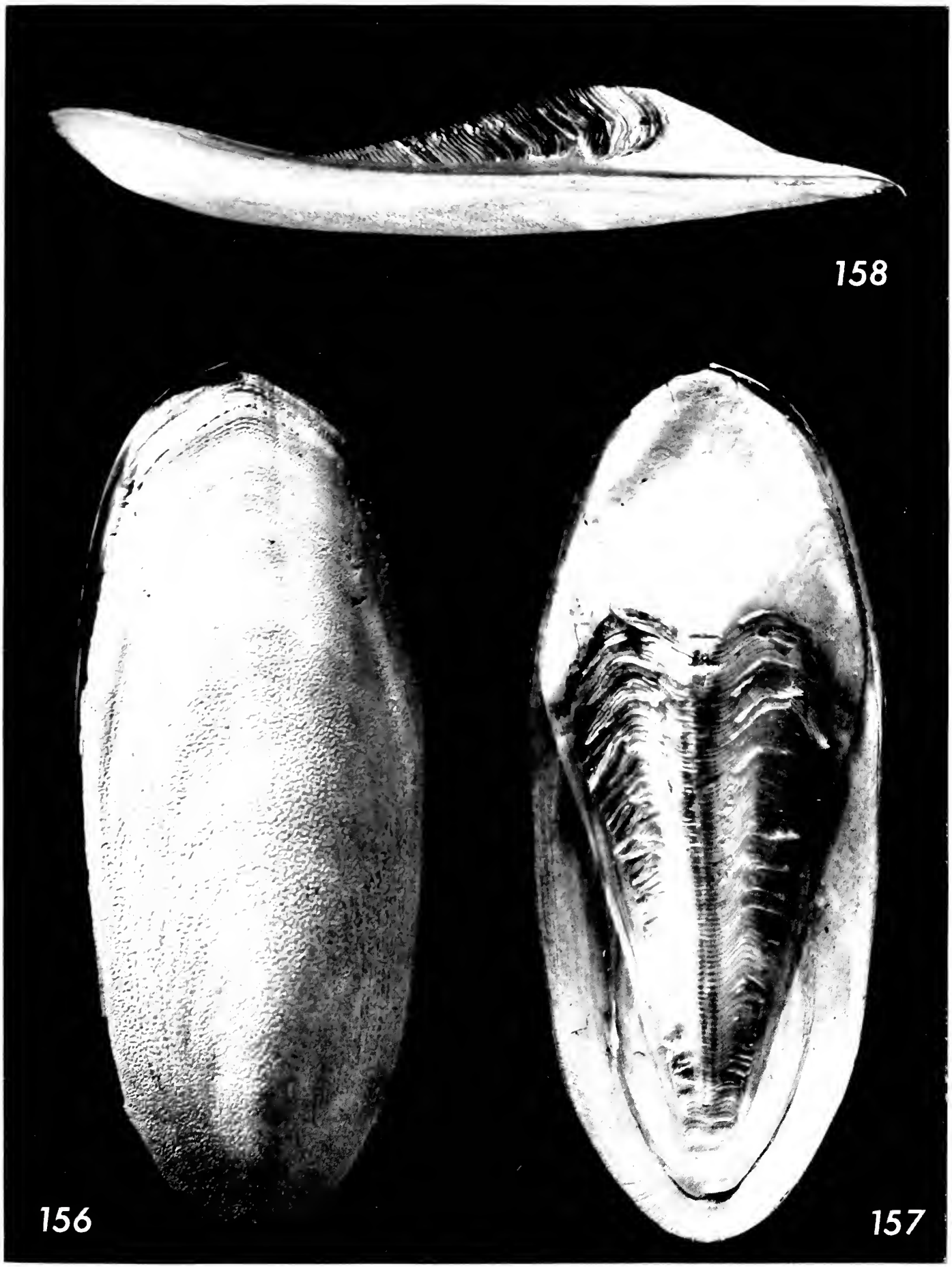

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PLATE 25

FIGS. 159–161. *Sepia gibba* Ehrenberg: ♀; dorsal, lateral and ventral views of shell (L. = 45 mm). Eylath, Gulf of Aqaba, Red Sea (Hebrew University, Jerusalem).

FIGS. 162 & 163. *Sepia elobyana* Adam: Holotype, ♂; dorsal and ventral views of shell (L. = 40 mm). Eloby Island, Atlantic coast of Africa (I.R.S.N.).

FIG. 164. *Sepia elobyana* Adam: ♂; ventral view of shell (L. = 47 mm). Gorée, Sénégal (I.R.S.N.).


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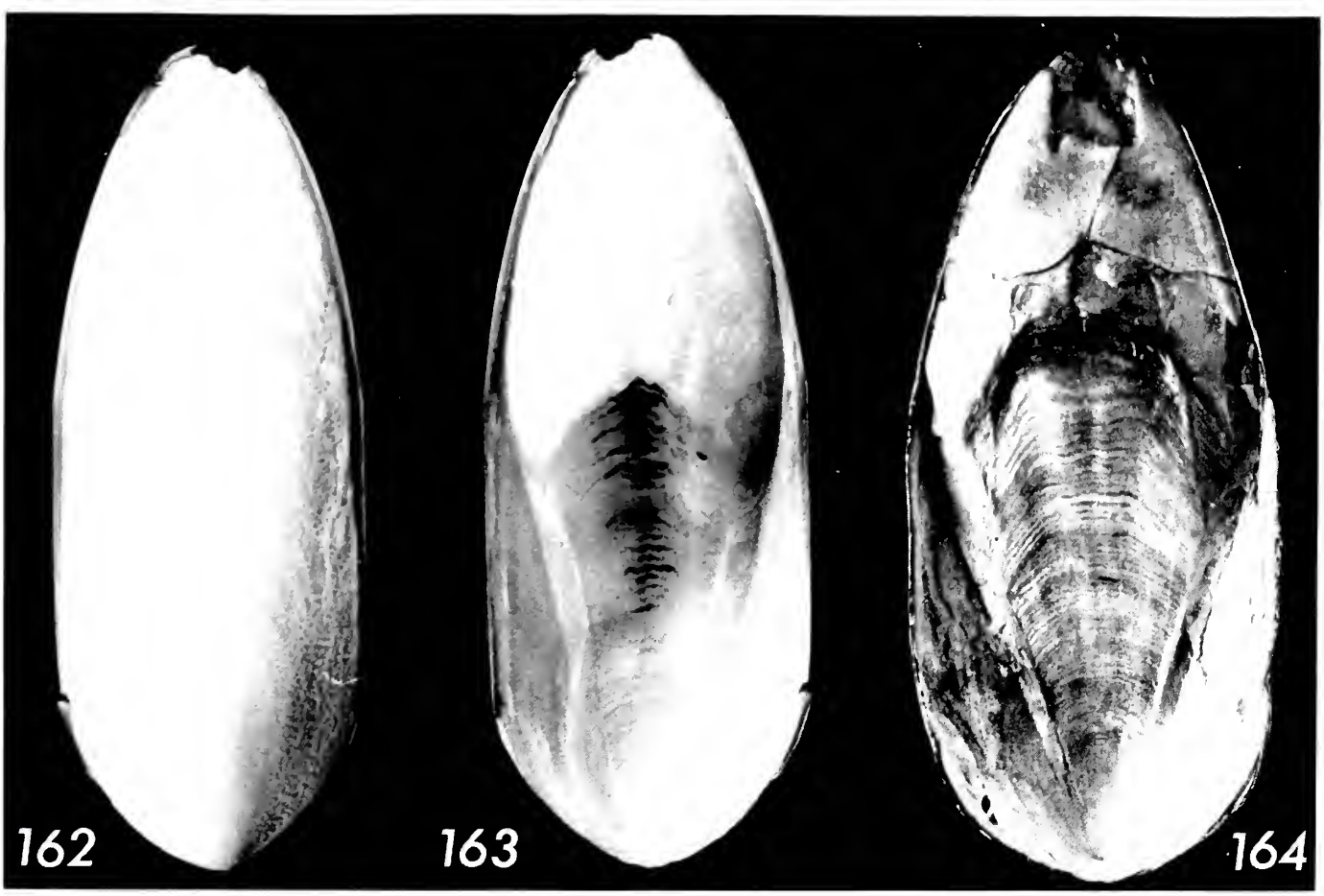

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PLATE 26

FIGS. 165 & 166. *Sepia bandensis* Adam: Syntype, ♂; dorsal and ventral views of shell (L. = 46 mm). Banda Neira, Indonesia (I.R.S.N.).

FIGS. 167 & 168. *Sepia bandensis* Adam: Syntype, ♀; dorsal and ventral views of shell (L. = 47·5 mm). Banda Neira (I.R.S.N., Bruxelles).

FIGS. 169 & 170. *Sepia tuberculata* Lamarck: dorsal and ventral views of shell (L. = 66+mm). Fort Dauphin, Madagascar (I.R.S.N.).


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PLATE 27

FIGS. 171 & 172. *Sepia tuberculata* Lamarck: ♀; dorsal and ventral views of whole animal of 64 mm in dorsal mantle-length. St. James, S. Africa (B.M. No. 1935.3.12.4).

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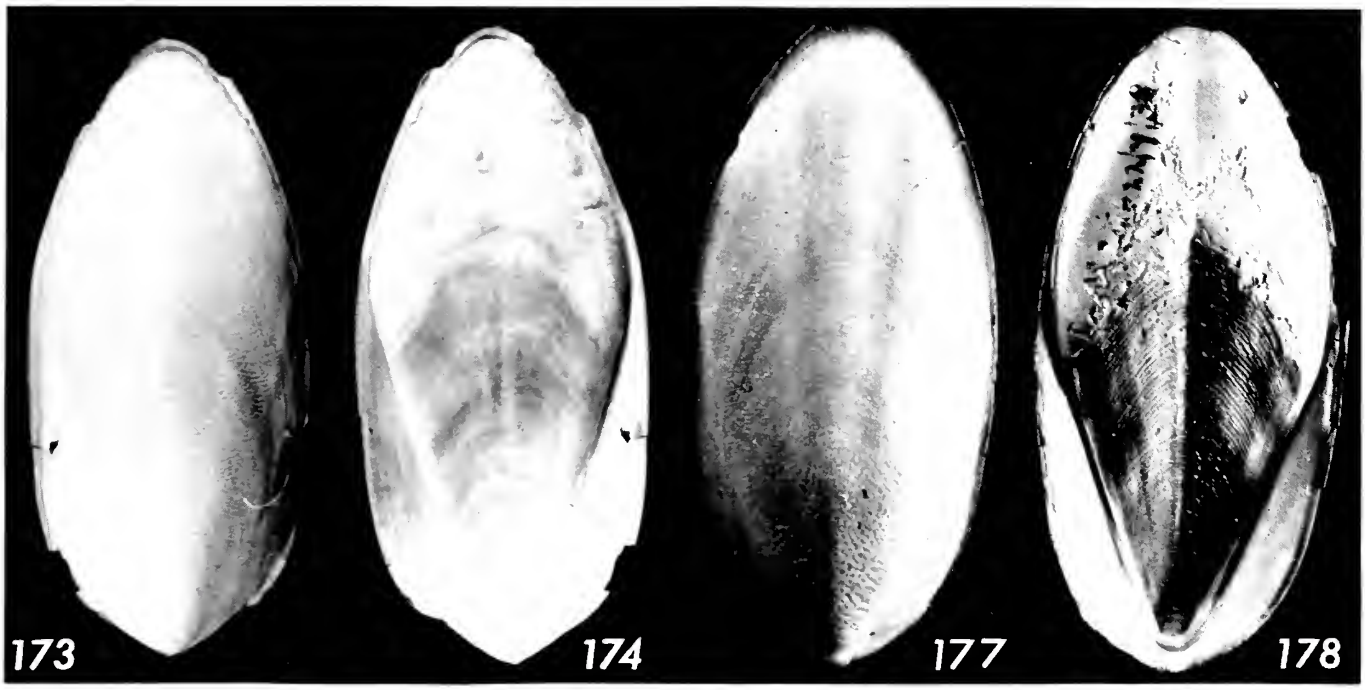
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PLATE 28

FIGS. 173 & 174. *Sepia tuberculata* Lamarck: ♀; dorsal and ventral views of shell (L. = 42 mm). Univ. Cape Town Ecological Survey, Knysna 189A, 14 July, 1950 (I.R.S.N.).

FIGS. 175 & 176. *Sepia papillata* Quoy & Gaimard: dorsal and ventral views of shell (L. = 108 mm). Port Elizabeth, South Africa (B.M. No. 1890.12.14.45).

FIGS. 177 & 178. *Sepia papillata* Quoy & Gaimard: dorsal and ventral views of shell (L. = 65·5 mm). Cape of Good Hope (Zoologisch Museum, Amsterdam).


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PLATE 29

FIGS. 179 & 180. *Sepia simoniana* Thiele: dorsal and ventral views of shell. Tomlin Collection, National Museum of Wales.

FIGS. 181 & 182. *Sepia ? simoniana* Thiele: dorsal and ventral views of shell (L. = 111 mm). Port Elizabeth, South Africa (B.M. No. 1890.12.14.41).


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PLATE 30

FIGS. 183 & 184. *Sepia* sp.: juv; dorsal and ventral views of shell (L. = 23 mm). John Murray Expedition, Sta. 27, near Cape Guardafui (B.M. No. 1963100W). Compare this shell with that of *S. simoniana* (pl. 29).

FIGS. 185 & 186. *Sepia myrsus* Gray: Holotype; dorsal and ventral views of shell (L. = 72 mm). China (B.M. No. 1841.4.6.89).

FIGS. 187 & 188. *Sepia hieronis* Robson: Syntype; dorsal and ventral views of shell (L. = 60 mm). Cape Town (B.M. No. 1924.9.9.54–5).


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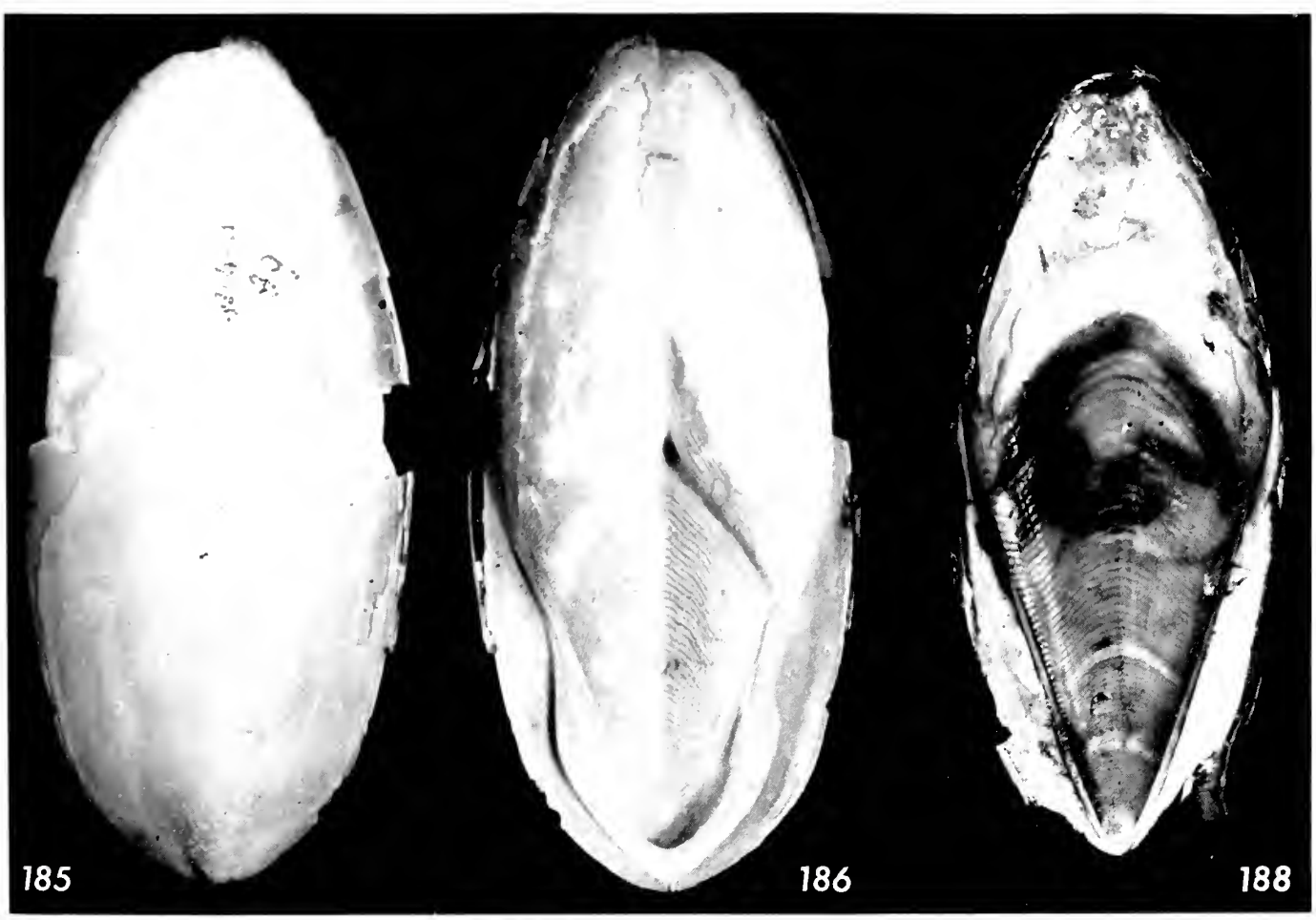

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PLATE 31

FIGS. 189–191. *Sepia insignis* Smith: Holotype; dorsal, ventral and lateral views of shell (L. = 26 mm). Tongaat Beach, Natal (B.M. No. 1920.3.23.5).

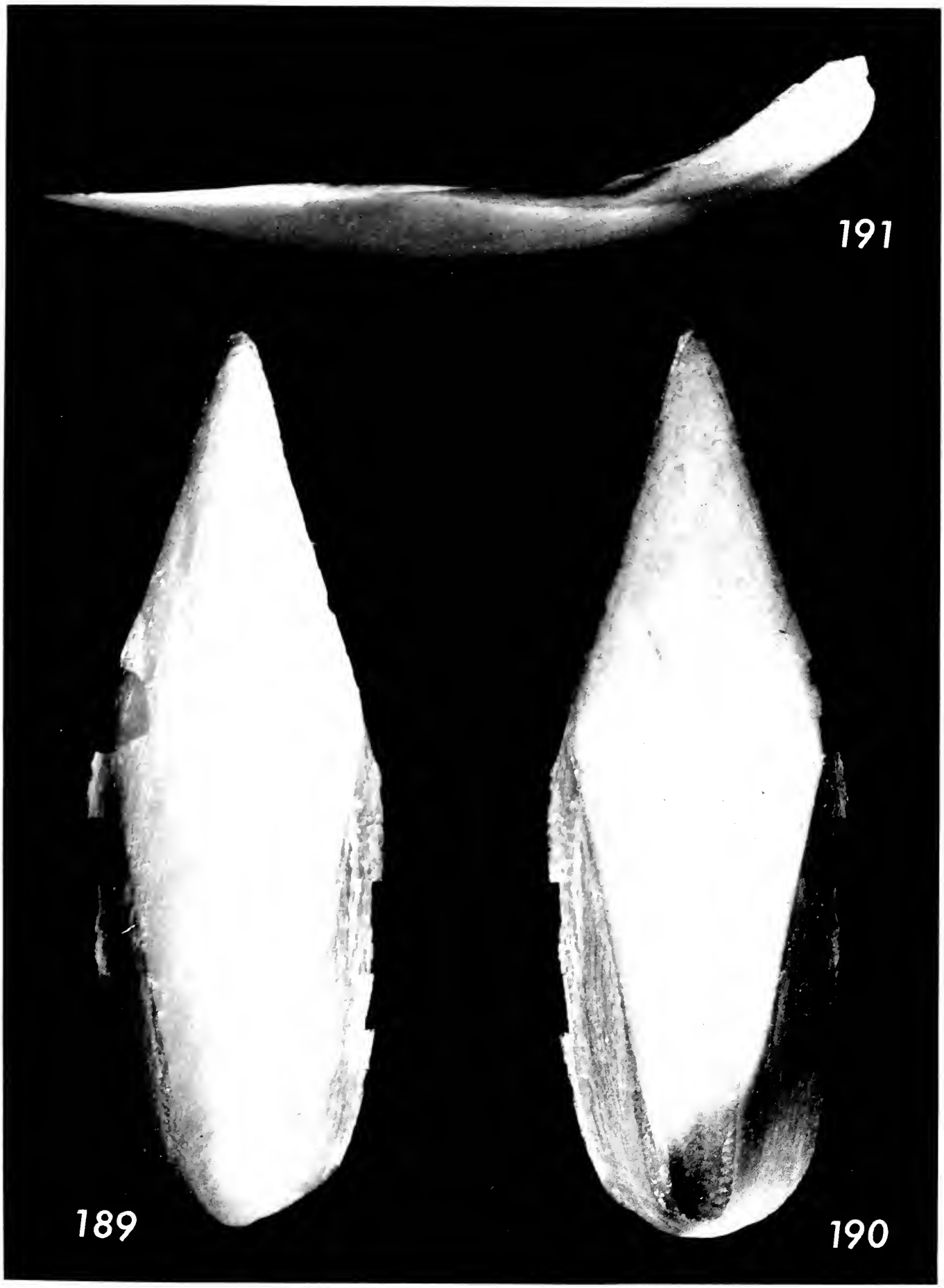

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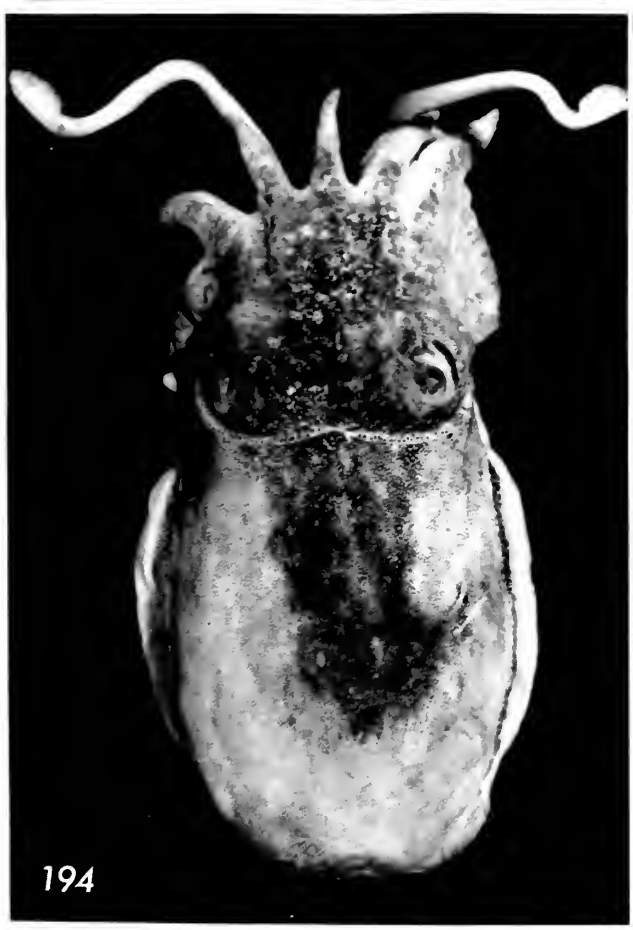
PLATE 32

FIGS. 192 & 193. *Sepia* (*Hemisepius*) *typica* (Steenstrup): ♂; dorsal and ventral views of whole animal (dorsal mantle-length, 20 mm). Details of locality as for Figs. 194 & 195.

FIGS. 194 & 195. *Sepia* (*Hemisepius*) *typica* (Steenstrup): ♀; dorsal and ventral views of whole animal (dorsal mantle-length, 24 mm). Coll. J. H. Day, Langebaan lagoon, L.B. 76, 15 July, 1946 (B.M. No. 1958.8.20.21–30).


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PLATE 33

FIG. 196. *Sepia* (*Hemisepius*) *typica* (Steenstrup): ♂; left hectocotylized ventral arm, 11 mm in length from specimen with a dorsal mantle-length of 19·5 mm. Langebaan lagoon, 15 July, 1946 (B.M. No. 1958.8.20.21–30).

FIG. 197. *Sepia* (*Hemisepius*) *typica* (Steenstrup): ♂; right ventral arm, 9·5 mm in length from a specimen with a dorsal mantle-length of 17·5 mm.


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PLATE 34

FIGS. 198 & 199. *Sepia* (*Hemisepius*) *dubia* sp. nov: Holotype, ♀; dorsal and ventral views of shell (L. = 14·5 mm). False Bay, S. Africa (B.M. No. 1963103W).

FIGS. 200 & 201. *Sepia* (*Hemisepius*) *dubia* sp. nov: Holotype, ♀; dorsal and ventral views of whole animal of dorsal mantle-length of 17 mm. False Bay (Univ. Cape Town Biol. Survey, No. FB 1007 (B.M. No. 1963103W)).


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PLATE 35

FIG. 202. *Sepiella ocellata* Pfeffer: Holotype, ♂; ventral view of shell (L. = 45·5 mm). Java.

FIGS. 203 & 204. *Sepiella ornata* (Rang): ♂; dorsal and ventral views of shell (L. = 85 mm). Position 5°55′S., 12°01′E. (I.R.S.N.).

FIGS. 205 & 206. *Sepiella ornata* (Rang): ♀; dorsal and ventral views of shell (L. = 77 mm). Position and data as for Figs. 203 & 204.

FIG. 207. *Sepiella ornata* (Rang): ♀; ventral view of shell (L. = 95 mm). Position and data as for Figs. 203 & 204.

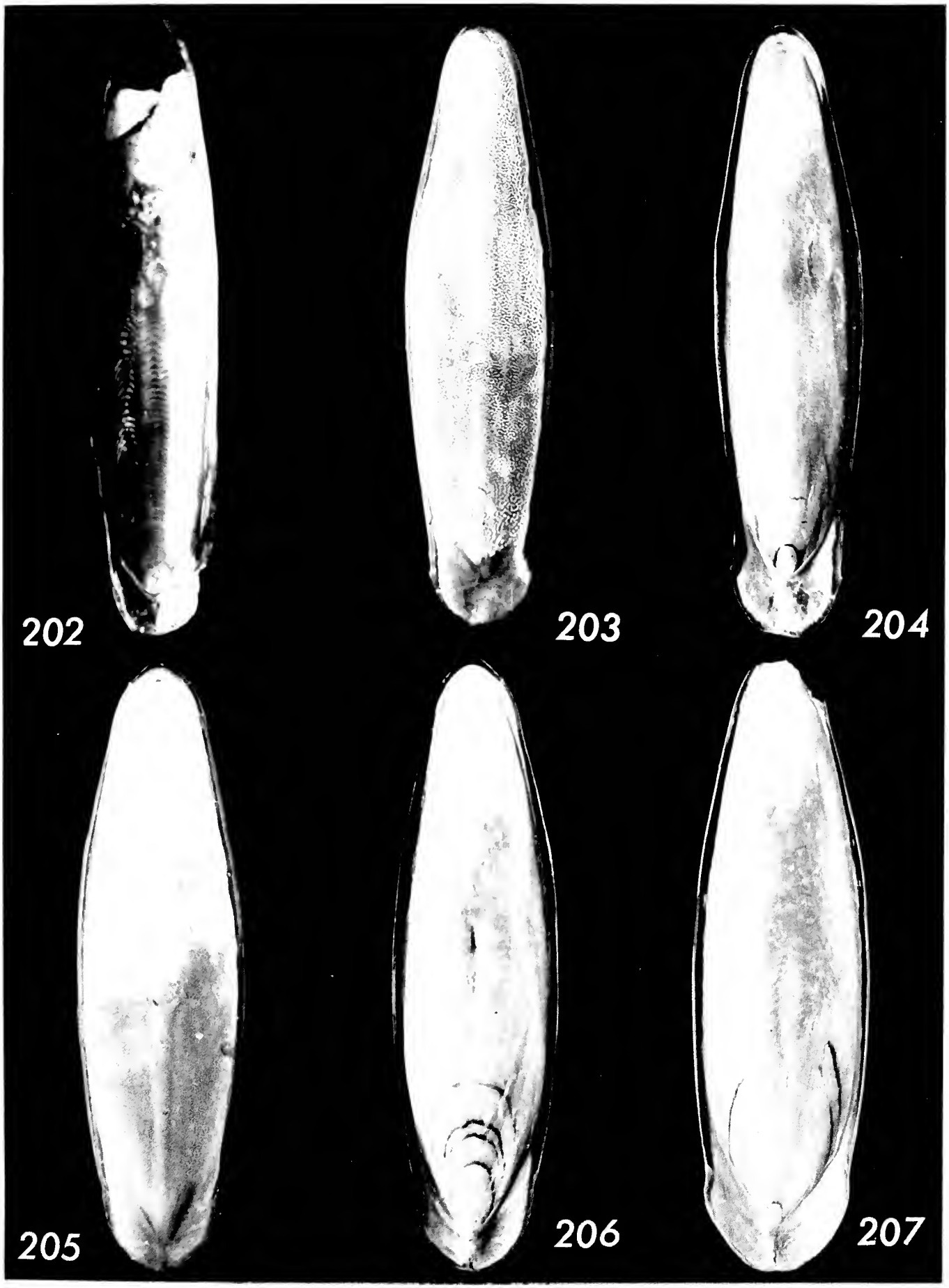

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PLATE 36

FIGS. 208 & 209. *Sepiella cyanea* Robson: Lectotype, ♂; dorsal and ventral views of shell (L. = 69 mm). Natal (B.M. No. 1924.9.9.40).

FIGS. 210 & 211. *Sepiella cyanea* Robson: ?♂; dorsal and ventral views of shell (L. = 76 mm). Isipingo, Natal (B.M. No. 1952.11.21.39–40).

FIGS. 212 & 213. *Sepiella cyanea* Robson: ♀; dorsal and ventral views of shell (L. = 95 mm). Isipingo, Natal (B.M. No. 1952.11.21.40).

FIG. 214. *Sepiella cyanea* Robson: Lectotype, ♂; hectocotylus, length 42 mm. Natal (B.M. No. 1924.9.9.40). See also Figs. 208 & 209 and 215.

FIG. 215. *Sepiella cyanea* Robson: Lectotype, ♂; left tentacular club, length 14 mm. Natal (B.M. No. 1924.9.9.40).

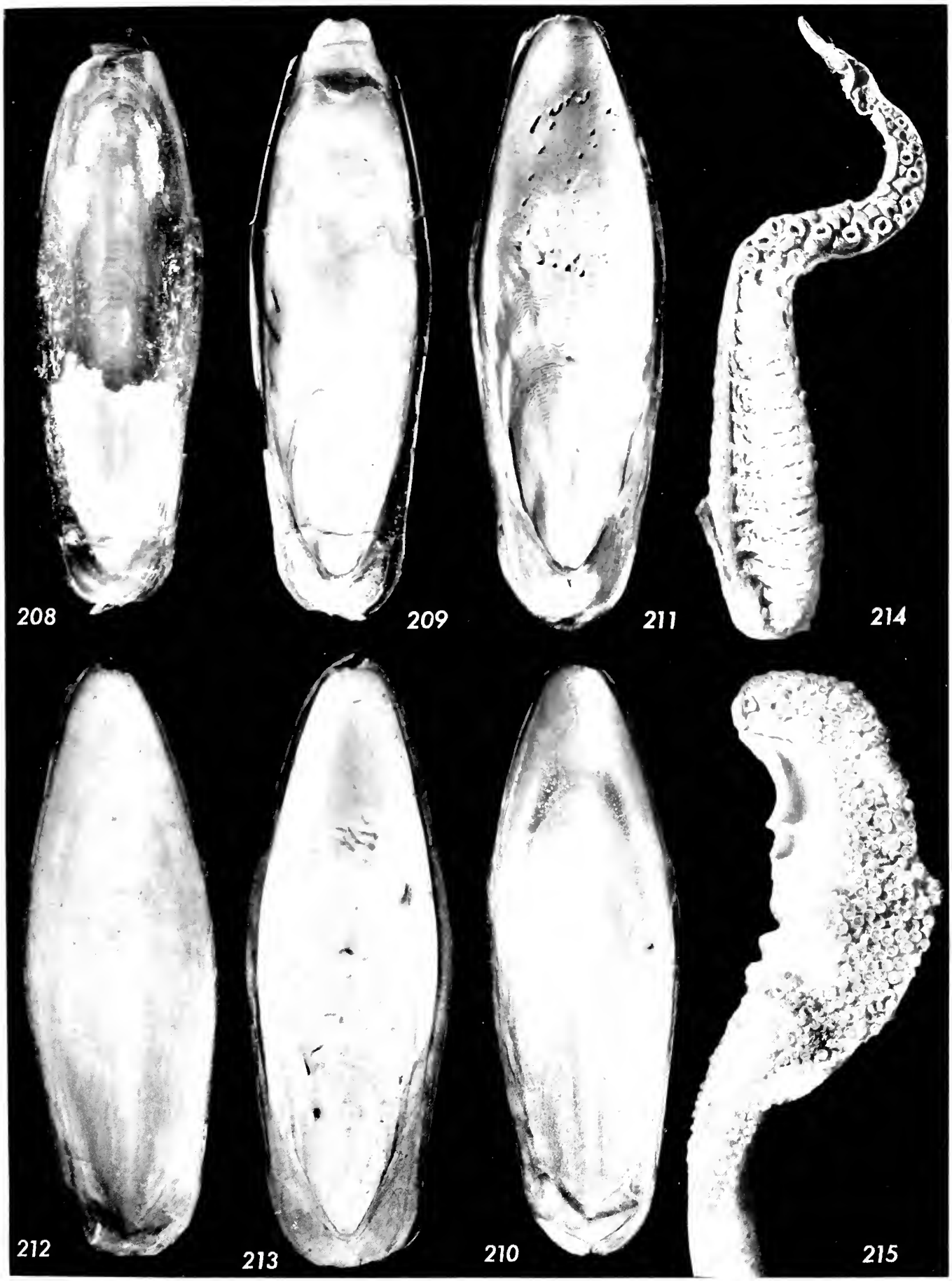

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PLATE 37

FIGS. 216 & 217. *Sepiella weberi* Adam: Syntype, ♂; dorsal and ventral views of shell (L. = 57·5 mm). Timor (Zoologisch Museum, Amsterdam).

FIGS. 218 & 219. *Sepiella weberi* Adam: Syntype, ♀; dorsal and ventral views of shell (L. = 67 mm). Soemba, Indonesia (Zoologisch Museum, Amsterdam).

FIGS. 220 & 221. *Sepia trygonina* (Rochebrune): ♂; dorsal and ventral views of whole animal of 40 mm, in dorsal mantle-length. John Murray Expedition, Sta. 10, Red Sea (B.M. No. 196386W).

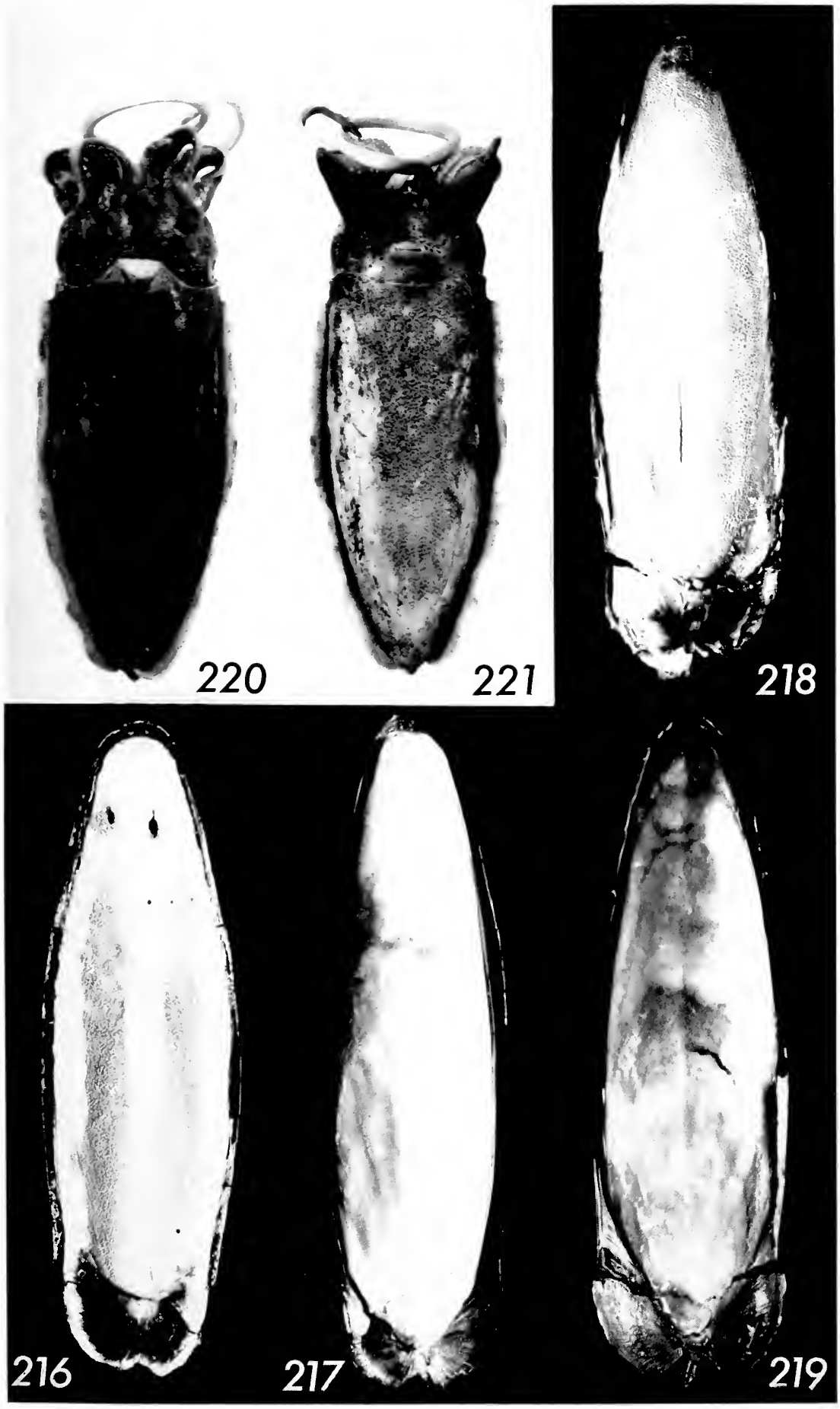

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PLATE 38

FIG. 222. *Sepiella inermis* (Férussac & d'Orbigny): ♀; ventral view of shell (L = 69 mm). Sumatra (B.M. No. 1879.10.4.1–2). For a dorsal view see pl. 40, Fig. 233.

FIGS. 223 & 224. *Sepiella inermis* (Férussac & d'Orbigny): ♀; dorsal and ventral views of shell (L. = 78 mm). Ennûr (B.M. No. 1952.11.24.9–11).

FIGS. 225 & 226. *Sepiella inermis* (Férussac & d'Orbigny): ♀; dorsal and ventral views of shell (L. = 90 mm). Aden, Coll. A. Fraser Brunner (B.M. No. 1963105W).

FIG. 227. *Sepiella inermis* (Férussac & d'Orbigny): ♀; dorsal view of whole animal, dorsal mantle-length, 93 mm. Aden, Coll. A. Fraser Brunner (See also Figs. 225 & 226).


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PLATE 39

FIGS. 228 & 229. *Sepiella japonica* Sasaki: ♂; dorsal and ventral views of shell (L. = 126 mm). Chee-foo, China (B.M. No. 1874.1.24.9).

FIGS. 230 & 231. *Sepiella japonica* Sasaki: ♀; dorsal and ventral views of shell (L. = 138 mm). Inland Sea of Japan (B.M. No. 1904.10.28.1–2).

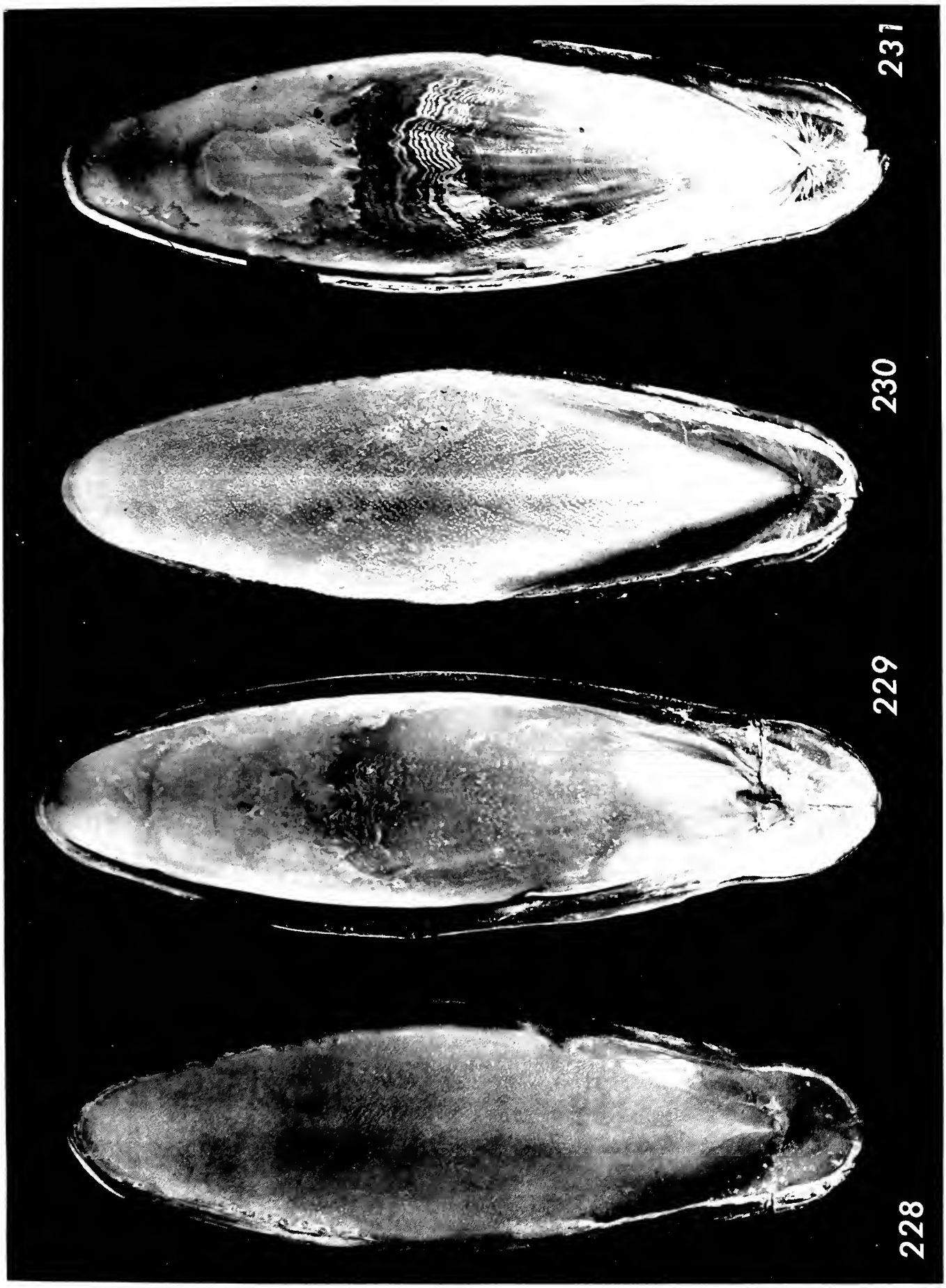

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PLATE 40

FIG. 232. *Sepiella ornata* Rang: ♀; dorsal view of shell (L. = 95 mm). Position, 5°55′S., 12°01′E. (I.R.N.S.).

FIG. 233. *Sepiella inermis* (Férussac & d'Orbigny): ♀; dorsal view of shell (L. = 69 mm). Sumatra (B.M. No. 1879.10.4.1–2). For a ventral view of this shell see Pl. 38, fig. 222.

FIG. 234. *Sepiella inermis* (Férussac & d'Orbigny): ♀; right tentacular club (tentacular club length, 28 mm). Aden, Coll. A. Fraser Brunner (B.M. No. 1963105W).

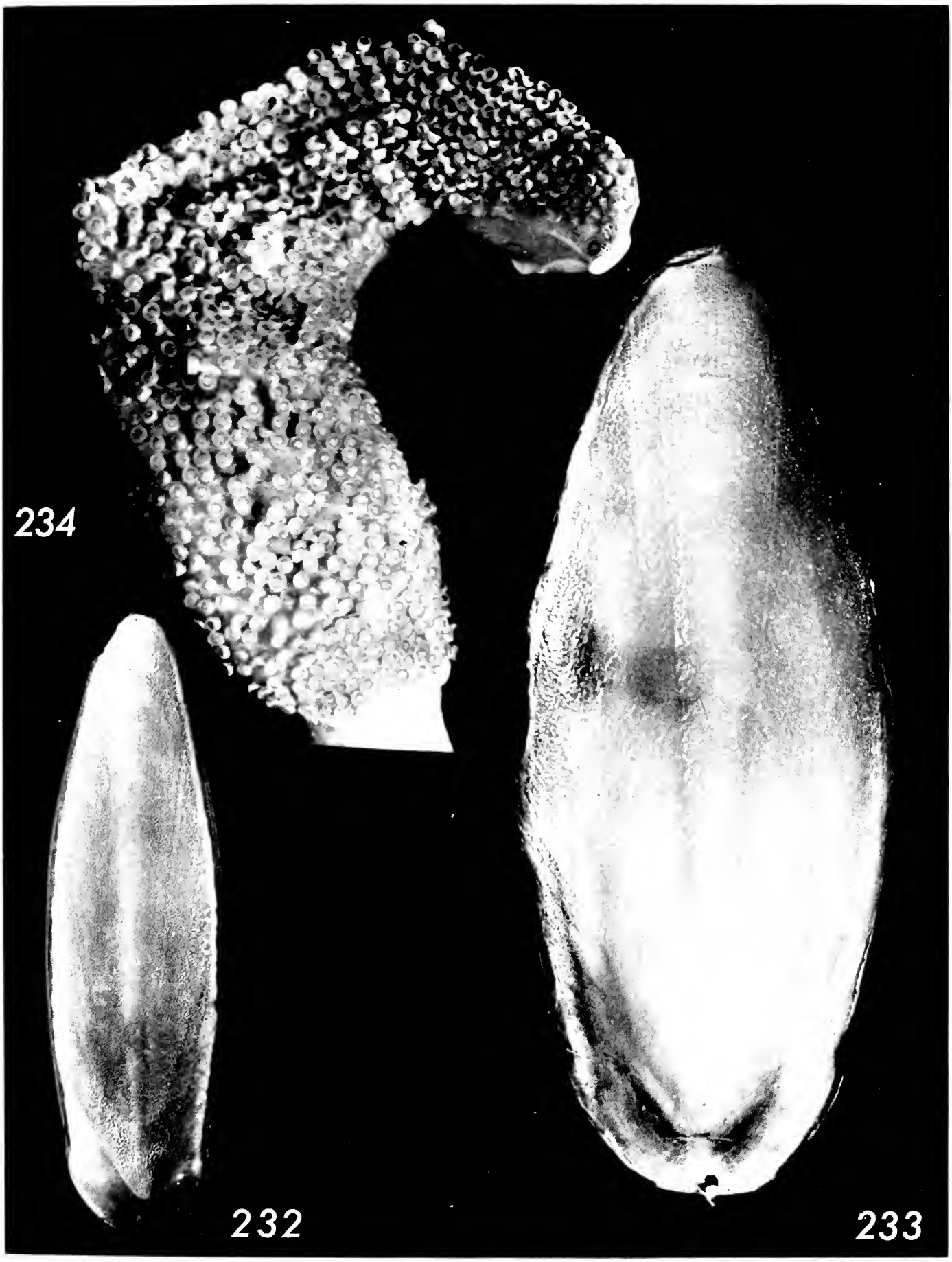

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PLATE 41

FIG. 235. *Sepia thurstoni* sp. nov: ♀; right tentacular club (T.cl., 15 mm). Negombo, Ceylon (B.M. No. 1917.5.5.36).

FIG. 236. *Sepia lycidas* Gray: ♀; left tentacular club (T.cl., 37 mm). Inland Sea of Japan (B.M. No. 1904.10.28.5).

FIG. 237. *Sepia dollfusi* Adam: ♂; right tentacular club (T.cl., 13 mm). Suez (B.M. No. 1947.5.5.46).

FIG. 238. *Sepia savignyi* Blainville: ♀; left tentacular club (T.cl., 25 mm). See also Pl. 42, Fig. 249. John Murray Expedition, Sta. 27, near Cape Guardafui.

FIG. 239. *Sepia smithi* Hoyle: Syntype, ♀; right tentacular club (T.cl., 19 mm). *Challenger* Sta. 188, Arafura Sea (B.M. No. 1889.4.24.66–67).

FIG. 240. *Sepia pharaonis* Ehrenberg: ♂; right tentacular club (T.cl., 20 mm). John Murray Expedition, Sta. 37, Gulf of Aden (B.M. No. 196356W).

FIG. 241. *Sepia incerta* Smith: ♂; left tentacular club (T.cl., 20 mm). Durban (B.M. No. 196385W).

FIG. 242. *Sepia omani* sp. nov: Holotype, ♂; left tentacular club (T.cl., 8 mm). John Murray Expedition, Sta. 75, Gulf of Oman (B.M. No. 1963107W).

FIG. 243. *Sepia omani* sp. nov.: Paratype, ♀; right tentacular club (T.cl., 9 mm). John Murray Expedition, Sta. 75, Gulf of Oman. The dorsal mantle-length of the animal was 53 mm (B.M. No. 1963108–114W).

FIG. 244. *Sepia omani* sp. nov.: Paratype, ♀; left tentacular club (T.cl., 9 mm). Details as for Fig. 243.

FIG. 245. *Sepia prashadi* Winckworth: ♂; left tentacular club (T.cl., 16 mm). John Murray Expedition, Sta. 75, Gulf of Oman (B.M. No. 196365–68W).

FIG. 246. *Sepia prashadi* Winckworth: ♀; left tentacular club (T.cl., 15 mm). Details as for Fig. 245.

FIG. 247. *Sepia zanzibarica* Pfeffer: Holotype, ♀; left and right tentacular clubs (T.cl., 35 mm). Zanzibar.

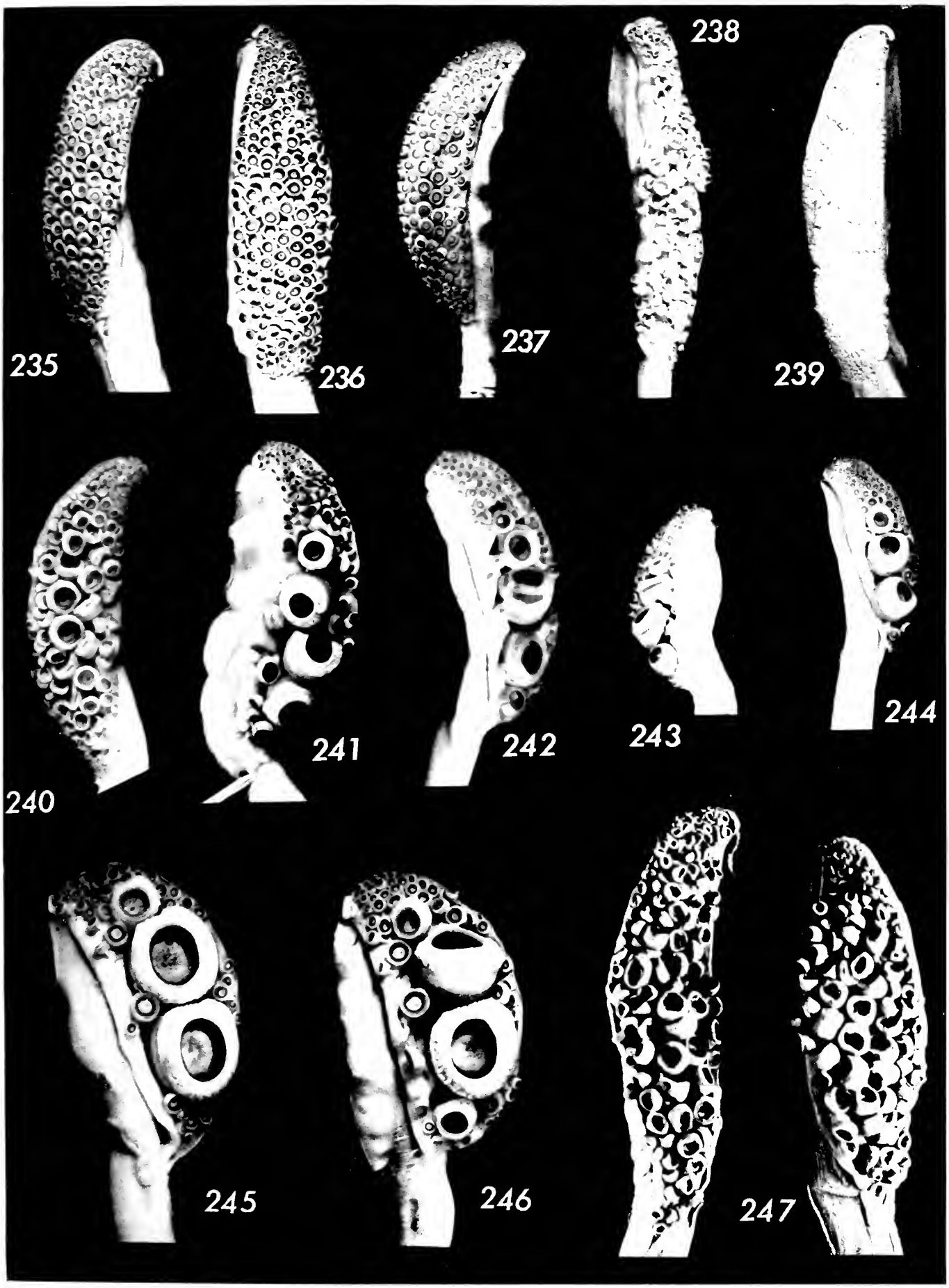

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PLATE 42

FIG. 248. *Sepia confusa* Smith: ♀; left tentacular club (T.cl., 20 mm). Durban (B.M. No. 196385W).

FIG. 249. *Sepia savignyi* Blainville: ♀; right tentacular club (T.cl., 18 mm). Kameran Island, Red Sea (B.M. No. 196354W. See also Pl. 41, Fig. 238).

FIG. 250. *Sepia papuensis* Hoyle: Syntype, ♂; left tentacular club (T.cl., 8 mm) from a specimen of 64 mm in dorsal mantle-length. *Challenger* Sta. 188, Arafura Sea (B.M. No. 1889.4.24.68).

FIG. 251. *Sepia aculeata* Férussac & d'Orbigny: ♂; right tentacular club (T.cl., 29 mm). Penang (B.M. No. 1860.6.2.86).

FIG. 252. *Sepia prionota* Voss: Paratype, ♀; left tentacular club (T.cl., 3·85 mm) from specimen of 36 mm in dorsal mantle-length. Off Sirun Island, Sulu Archipelago (Smithsonian Institution).

FIG. 253. *Sepia pageora* (Iredale): ♂; left tentacular club (T.cl., 33 mm). Cape Upstart, Australia (B.M. No. 1963118W).

FIG. 254. *Sepia simoniana* Thiele: ♀; left tentacular club (T.cl., 85 mm). 18 miles east of Cape Agulhas, S. Africa (University of Cape Town Ecological Survey, T.R.A., 27C) (B.M. No. 196388W).

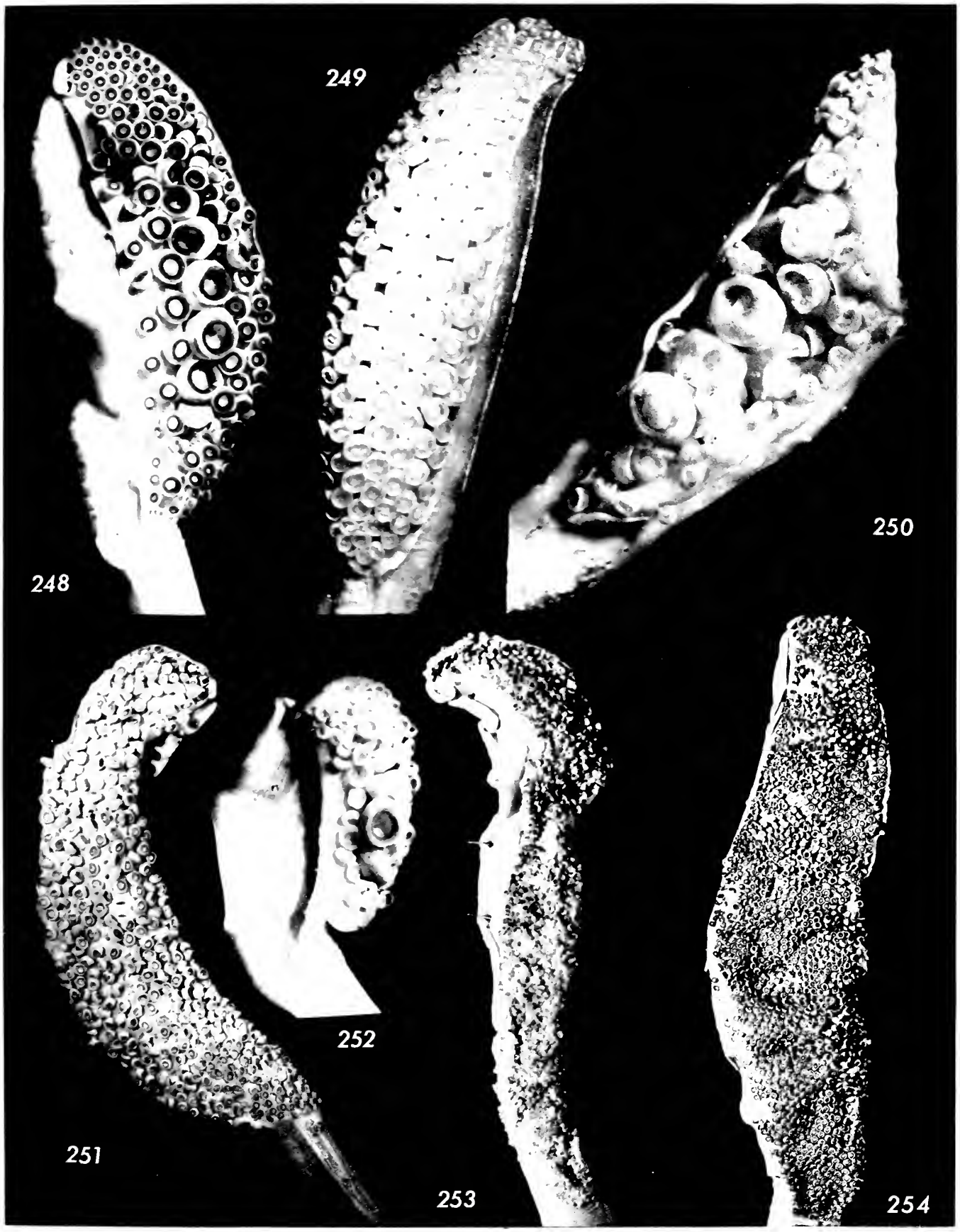

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PLATE 43

FIG. 255. *Sepia kobiensis* Hoyle: Holotype, ♀; right tentacular club (T.cl., 3·1 mm). *Challenger* Sta. 233, Bay of Kobe, Japan (B.M. No. 1889.4.24.81).

FIG. 256. *Sepia* (*Metasepia*) *pfefferi* Hoyle: Holotype, ♀; left tentacular club (T.cl., 6 mm). *Challenger* Sta. 188, Arafura Sea (B.M. No. 1890.1.24.11).

FIG. 257. *Sepia joubini* Massy: Syntype, ♂; left tentacular club (T.cl., 3·5 mm). Cape Natal (B.M. No. 1926.10.20.39–40).

FIG. 258. *Sepia elliptica* Hoyle: Syntype, ♀; right tentacular club (T.cl., 8 mm) from specimen of 54 mm in dorsal mantle-length. *Challenger* Sta. 190, Arafura Sea (B.M. No.1889. 4.24.74).

FIG. 259. *Sepia appellöfi* Wülker: ♀; left tentacular club (T.cl., 13·5 mm) of specimen of 90 mm in dorsal mantle-length. Sagami Bay, Japan (B.M. No. 1910.9.29.1).

FIG. 260. *Sepia murrayi* sp. nov.: Paratype; ♀; left tentacular club (T.cl., 4 mm) of specimen of 40 mm in dorsal mantle-length. John Murray Expedition, Sta. 71, Gulf of Oman (B.M. No. 196382W).

FIG. 261. *Sepia acuminata* Smith: ♀; left tentacular club (T.cl., 10 mm). Natal (Sta. 95) (B.M. No. 1924.9.9.72–3).

FIG. 262. *Sepia hieronis* (Robson): ♀; left tentacular club (T.cl., 6 mm). S. African coast (B.M. No. 1958.8.20.7).

FIG. 263. *Sepia esculenta* Hoyle: ♂; left tentacular club (T.cl., 23 mm). Inland Sea of Japan (B.M. No. 1904.10.28.3–4).


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PLATE 44

FIG. 264. *Sepia kobiensis* Hoyle: Syntype, ♂, of *S. andreanoides*; right tentacular club (T.cl., 6 mm) of specimen of 60 mm dorsal mantle-length (B.M. No. 1889.4.24.78).

FIG. 265. *Sepia tuberculata* Lamarck: ♀; right tentacular club (T.cl., 20 mm) from specimen of 64 mm in dorsal mantle-length. St. James, South Africa (B.M. No. 1935.3.12.4). See also Fig. 268.

FIG. 266. *Sepia bandensis* Adam: Syntype, ♂; right tentacular club (T.cl., 8 mm) from specimen of 47 mm in dorsal mantle-length. Banda Neira (I.R.S.N.).

Fig. 267. *Sepia plangon* Gray: ♂; left tentacular club (T.cl., 11 mm) from specimen of 95 mm in dorsal mantle-length. Port Jackson, Australia (B.M. No. 196374W).

FIG. 268. *Sepia tuberculata* Lamarck: ♂; right tentacular club (T.cl., 11 mm). Exact locality unknown (B.M. No. 1868.6.8.1).

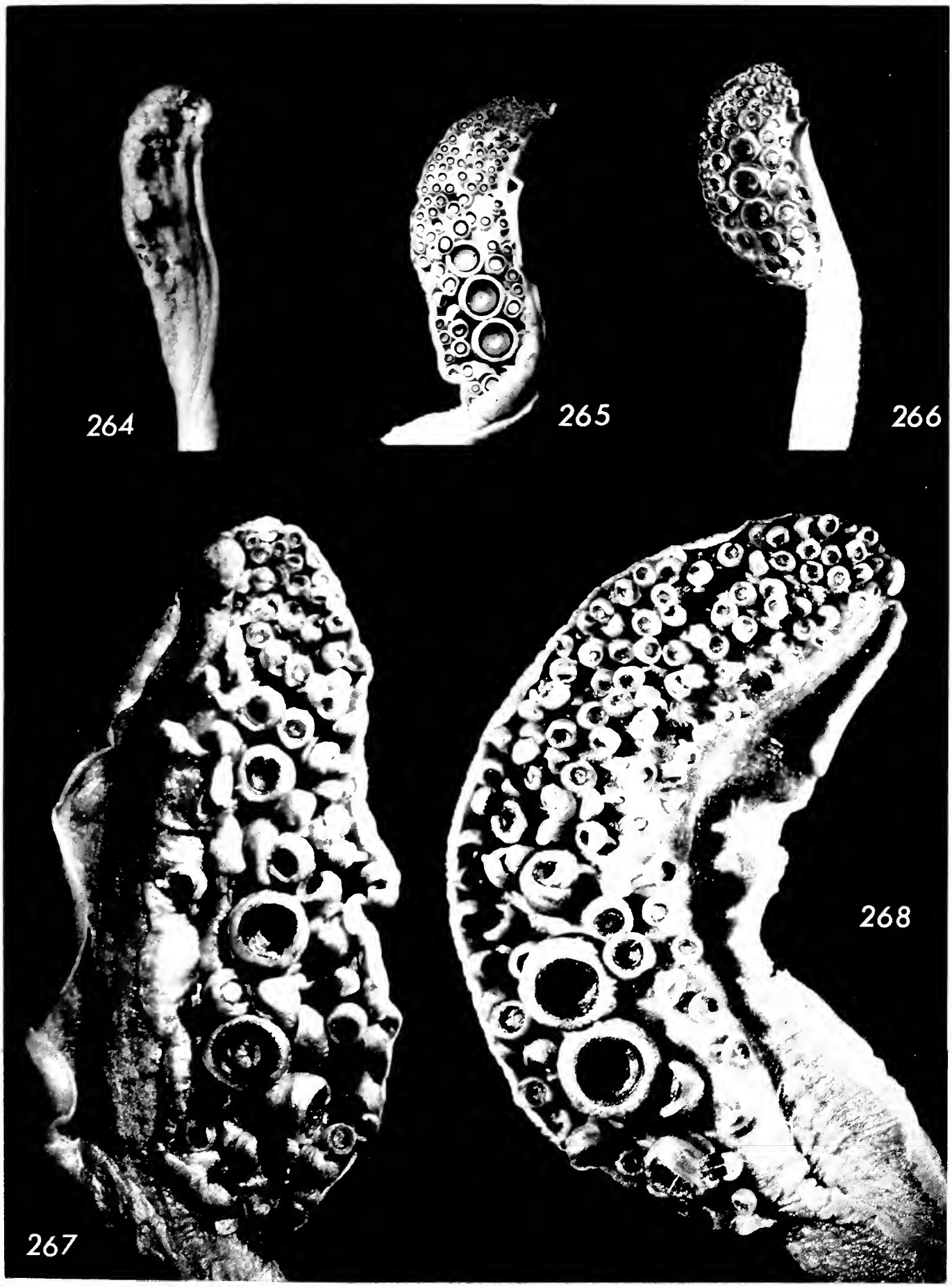

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PLATE 45

FIG. 269. *Sepia apama* Gray: ♀; tentacular clubs (T.cl., 70–75 mm) from a specimen of 300 mm in dorsal mantle-length. Cobblers Beach, Port Jackson, Australia (B.M. No. 1890.6.21.1).

FIG. 269A. *Sepia latimanus* Quoy & Gaimard: ♀; right tentacular club (T.cl., 65 mm) Fish market, Singapore (B.M. No. 1947.5.16.1).

FIG. 270. *Sepia australis* Quoy & Gaimard: ♂; right tentacular club (T.cl., 6 mm) from specimen of 55 mm in dorsal mantle-length. Cape Town (B.M. No. 1924.9.9.62–69).

FIG. 271. *Sepia officinalis vermiculata* Quoy & Gaimard: ♂; left tentacular club (T.cl., 50 mm) from specimen of 148 mm in dorsal mantle-length. Natal (B.M. No. 1924.9.9.41–42).

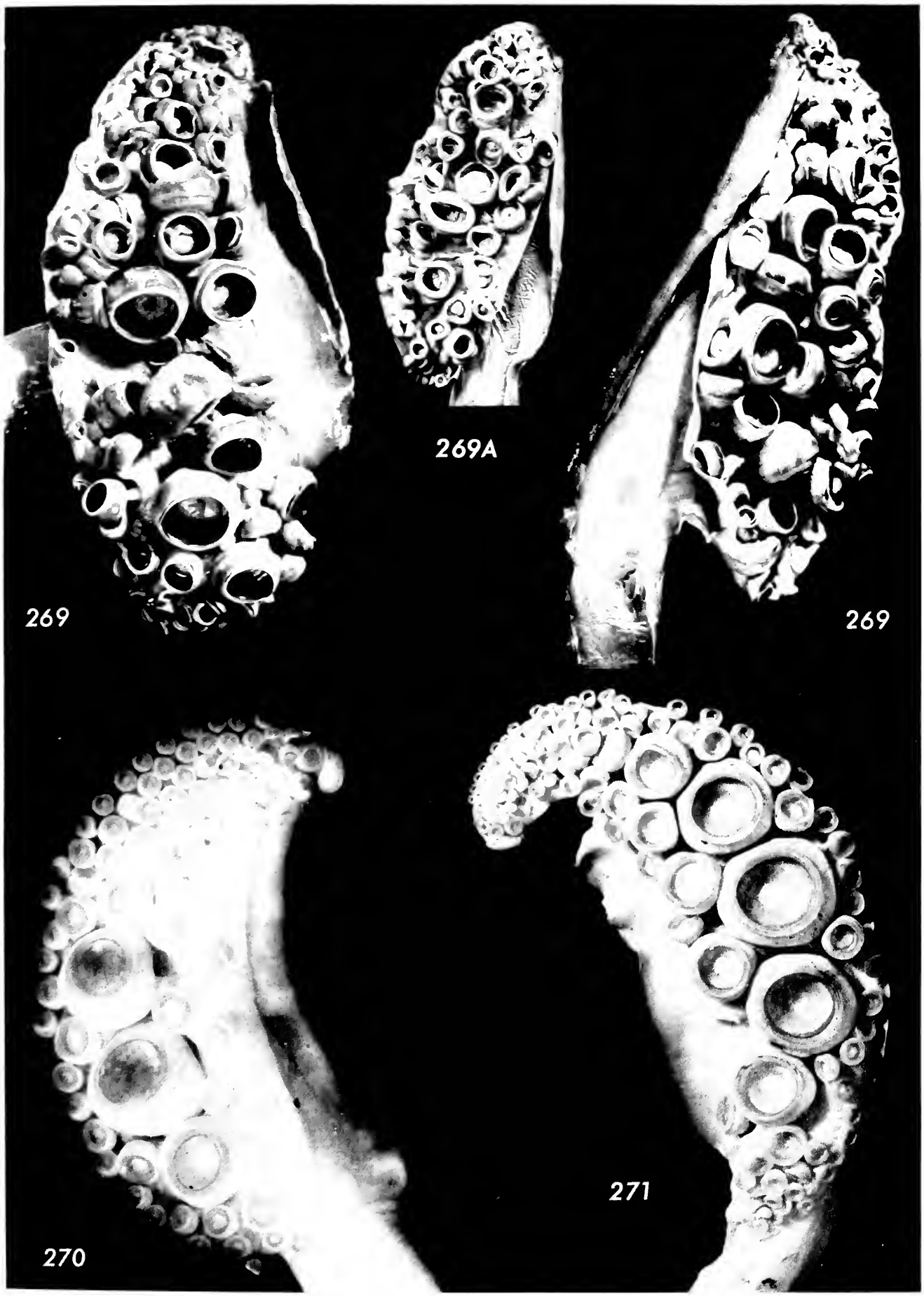

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PLATE 46

FIG. 272. *Sepia* (*Hemisepius*) *dubia* sp. nov.: Holotype, ♀; left tentacular club (T.cl., 2 mm) from specimen of 17 mm in dorsal mantle-length. False Bay, South Africa; University of Cape Town Ecological Survey No. F.B. 1007 (B.M. No. 1963103W).

FIG. 273. *Sepia sewelli* sp. nov.: Holotype, ♀; left tentacular club (T.cl., 3·5 mm). John Murray Expedition, Sta. 27, near Cape Guardafui (B.M. No. 196378W).

FIG. 274. *Sepia mestus* Gray: right tentacular club (T.cl., 3·5 mm) from specimen of 47 mm in dorsal mantle-length. North China (B.M. No. 1863.5.1.6).

FIG. 275. *Sepia sulcata* Hoyle: Holotype, ♂; left tentacular club (T.cl., 5 mm) from specimen of 53 mm in dorsal mantle-length. *Challenger* Sta. 192, Arafura Sea (B.M. No. 1889.4.24.77).

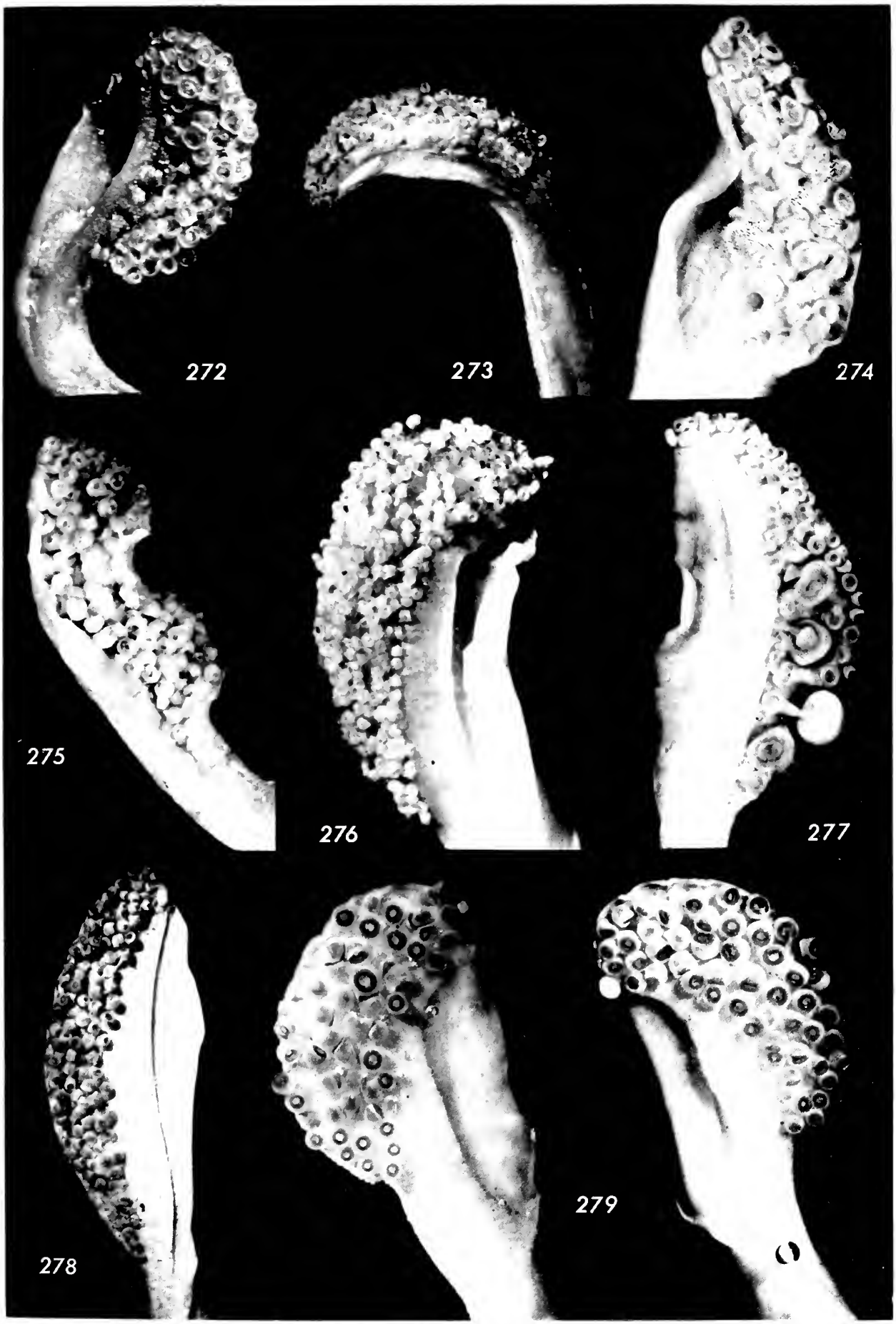
FIG. 276. *Sepia* sp.: juvenile; right tentacular club (T.cl., 3·5 mm) from young specimen of 23·5 mm in dorsal mantle-length. John Murray Expedition, Sta. 27, near Cape Guardafui (B.M. No. 196399W).

FIG. 277. *Sepia trygonina* (Rochebrune): ♀; left tentacular club (T.cl., 4·5 mm) of specimen of 50 mm in dorsal mantle-length. John Murray Expedition, Sta. 27, near Cape Guardafui (B.M. No. 196388–94W).

FIG. 278. *Sepia arabica* Massy: ♂; right tentacular club (T.cl., 5 mm) from specimen of 67 mm in dorsal mantle-length. John Murray Expedition, Sta. 194, Gulf of Aden (B.M. No. 196386W).

FIG. 279. *Sepia robsoni* (Massy): Holotype, ♂; tentacular clubs (T.cl., 2·5 mm) from specimen of 17 mm in dorsal mantle-length. Hout Bay, S. Africa (B.M. No. 1926.10.20.8).

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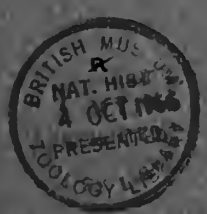
SCIENTIFIC REPORTS

VOLUME XI, No. 2

CRUSTACEA: GALATHEIDAE

BY

NASIMA M. TIRMIZI



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LONDON : 1966

CRUSTACEA: GALATHEIDAE

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INTRODUCTION

The Indian Ocean Galatheidae obtained by the " John Murray " Expedition are referable to thirty species and one variety which are distributed among four genera as follows : The genus *Galathea* is represented by nine species, *Munida* by eight (sub-family Galatheinae), *Galacantha* by two and *Munidopsis* by eleven species and one variety (sub-family Munidopsinae). Of these *Galathea cymbulaerostris*, *Munida roshanei* and *Munidopsis* (*Munidopsis*) *wardeni* Anderson var. *mabahiss* are described as new.

Galathea pusilla Henderson, *G. aculeata* Haswell, *G. pubescens* and probably *G. whiteleggei* are recorded for the first time from the Indian Ocean. The " John Murray " species of *Galathea* were taken at depths between 29–457, *Munida* 55–1170, *Galacantha* 1789–2080, and *Munidopsis* 494–2312 metres. The maximum number of species was collected from the Zanzibar area.

Through the kindness of the authorities I was able to study named material of Galatheidae in the collection of the British Museum (Nat. Hist.), Muséum National D'Histoire Naturelle, Paris, and Zoologisch Museum, Amsterdam. Specimens determined by Melin of *Galathea orientalis*, *G. ternatensis* and *G. serrirostris* were kindly sent on loan from Naturhistoriska Riksmuseet, Stockholm.

The following abbreviations have been used : c.l. = carapace length from the orbital border to the posterior margin of the carapace ; c.l. + r. = carapace length from the tip of the rostrum to the posterior margin of the carapace ; ch.l. = length of the cheliped.

The " John Murray " material on which the present report is based will be deposited in the British Museum (Nat. Hist.).

GEOGRAPHICAL DISTRIBUTION OF THE GALATHEIDEA COLLECTED

St. B. rectangular dredge, 16 fathoms [Data on label insufficient could be M.B. I (b)—Red sea, 29 metres.]

Galathea gardineri Laurie
aculeata Haswell
orientalis Stimpson

South Arabian coast:

St. M.B. II (c), rectangular dredge, 29 metres.

Galathea cymbulaerostris n. sp.

St. 43, otter trawl, 83–100 metres.

Galathea orientalis Stimpson

St. 45, triangular dredge 4, 38 metres.

Galathea orientalis Stimpson
whiteleggei Grant and McCulloch

St. 50, triangular dredge 4, 1536–1939 metres.
Munidopsis (*Munidopsis*) *dasypus* Alcock
St. 54, Agassiz trawl, 1046 metres.
Munidopsis (*Munidopsis*) *spinihirsuta* Lloyd
(*Munidopsis*) *scobina* Alcock
(*Galathodes*) *trifida* Henderson

Red Sea:
St. 9, otter trawl, 30 fathoms [= ? St. 10 ; net and depth on the label seem to agree with those for St. 10 of the same date in the published station list].
Galathea gardineri Laurie
aculeata Haswell
elegans Adams and White
Munida japonica Stimpson
St. 10, otter trawl, 55 metres.
Galthea pusilla Henderson
gardineri Laurie

Gulf of Aden:
St. 26, Agassiz trawl, 2312 metres.
Galacantha rostrata A. Milne-Edwards
Munidopsis (*Orophorynchus*) *ciliata* Wood-Mason
St. 34, Agassiz trawl, 1022 metres.
Munida andamanica Alcock
Munidopsis (*Munidopsis*) *wardeni* Anderson *mabahiss* var. nov.
St. 35, otter trawl, 457–549 metres.
Munida andamanica Alcock
St. 184, Agassiz trawl, 1270 metres.
Munidopsis (*Munidopsis*) *dasypus* Alcock
(*Galathodes*) *trifida* Henderson
(*Elasmonotus*) *cylindrophthalmus* Alcock
St. 185, Agassiz trawl, 2000 metres.
Galacantha rostrata Milne-Edwards
Munidopsis (*Munidopsis*) *stylirostris* Wood-Mason
St. 188, Agassiz trawl, 528 metres.
Munida roshanei n. sp.
andamanica Alcock

Northern area of Arabian Sea:
St. 62, Agassiz trawl, 1893 metres.
Galacantha rostrata A. Milne-Edwards
trachynotus Anderson

Gulf of Oman:
St. 71, otter trawl, 106 metres.
Munida roshanei n. sp.

Zanzibar area:
St. 106, Agassiz trawl, 183–194 metres.
Munida japonica Stimpson
tricarinata Alcock

St. 107, Agassiz trawl, 421–457 metres.
Galathea pubescens Stimpson
Munida vigiliarum Alcock
incerta Henderson
St. 108, Agassiz trawl, 732 metres.
Munidopsis (*Munidopsis*) *wardeni* Anderson
St. 109, Agassiz trawl, 640 metres.
Munida andamanica Alcock
Munidopsis (*Bathyankyristes*) *tenax* Alcock
St. 111, Agassiz trawl, 73–165 metres.
Galathea spinosorostris Dana
St. 112, Peterson type, 113 metres.
Munida elegantissima de Man
St. 115, otter trawl, 640–658 metres.
Munida incerta Henderson.
St. 118, Agassiz trawl, 1789 metres.
Galacantha rostrata Milne-Edwards
St. 122, otter trawl, 732 metres.
Munidopsis (*Munidopsis*) *wardeni* Anderson

Maldive area:
St. 143, Agassiz trawl, 797 metres.
Munidopsis (*Munidopsis*) *wardeni* Anderson
(*Munidopsis*) *wardeni mabahiss* var. nov.
(*Bathyankyristes*) *tenax* Alcock
St. 145, Agassiz trawl, 494 metres.
Munidopsis (*Elasmonotus*) *cylindrophthalmus* Alcock
(*Galathodes*) *regia* Alcock and Anderson
St. 149, triangular dredge 4, 238 metres.
Munida tricarinata Alcock
St. 153, triangular dredge 4, 256–293 metres.
Munida tricarinata Alcock
St. 154, Agassiz trawl, 457 metres.
Munida andamanica Alcock
tricarinata Alcock
St. 158, Agassiz trawl, 686–1170 metres.
Munida microps Alcock

Family **GALATHEIDAE** Dana

The family Galatheidae is at present divided into two sub-families with the following genera: sub-family Galatheinae Ortman : *Galathea* Fabr., *Munida* Leach, *Bathymunida* Balss, *Cervimunida* Benedict, and *Pleuroncodes* Stimpson ; sub-family Munidopsinae Ortman : *Galacantha* A. Milne-Edwards and *Munidopsis* Whiteaves. Both genera of the Munidopsinae are represented in the " John Murray " collection but only two of the Galatheinae genera, namely, *Galathea* and *Munida*.

Key to the determination of the sub-families and Indian Ocean genera of the family Galatheidae

I. Integument crisp, not strongly calcified ; carapace with well-developed hairy striae ; eyes facetted and well pigmented ; exopod of first maxilliped terminates in a flagellum . . . . . Galatheinae Ortman
  A. Rostrum triangular, flat or concave dorsally, lateral margins with spines . . . . . ***Galathea*** Fabr.
  B. Rostrum styliform, flanked by supra-orbital spines . . . . . ***Munida*** Leach

II. Integument thick, strongly calcified ; transverse, hairy striae of carapace weak or absent ; eyes non-facetted and non-pigmented ; exopod of first maxilliped does not terminate in a flagellum . . Munidopsinae Ortman
  A. Rostrum with a horizontal basal, and an abruptly upturned distal, part ; carapace with one or more mid-dorsal gigantic spines . . . . . ***Galacantha*** A. Milne-Edwards
  B. Rostrum horizontal, carapace without mid-dorsal spines . . . . . ***Munidopsis*** Whiteaves

Sub-family **GALATHEINAE** Ortman

Genus ***GALATHEA*** Fabr.

The genus *Galathea* comprises over fifty species the great majority of which are found in the Indo-Pacific region. Unfortunately, several species of the genus are still poorly known : the original descriptions of many are inadequate and often without figures and the types are not always accessible. Moreover, very little is known about the variations which may occur with age and sex.

Doflein and Balss in 1913 tabulated the geographical and bathymeteric distribution of the species known to them (1913, p. 169). Since then various authors have suggested various alterations, for example : Bull (1936) has shown/that *G. dispersa* Bate is a species distinct from *G. nexa* Embleton. Grant and McCulloch, after comparing the specimens of *G. australiensis* Stimpson with the four type specimens of *G. corallicola* Haswell, regard the latter as a synonymy of *G. australiensis* (1906, p. 45). This view was adopted by Melin who also regarded *G. aegyptica* Paulson as a synonym of it (1939, p. 56). And Balss himself (in 1915, p. 2) had put *aegyptica* Paulson, *brevimanus* Paulson and *longimanus* Paulson as synonyms of *australiensis*. Further, Grant and McCulloch considered only *G. deflexifrons* Haswell as synonymous with *G. elegans*, they neither included *longirostris* Dana nor agreed with Henderson in regarding it as identical with *grandirostris* Stimpson. Laurie (1926, p. 134), however, says that " There does not appear to me to be any distinction of specific value between *elegans*, *grandirostris*, *longirostris* and *deflexifrons*." Melin (1939) considers only *grandirostris* as a synonymy of *elegans*. The diagnostic features of certain closely related species are still imperfectly known, such as those between *orientalis* Stimpson and *acanthomera* of the same author.

As far as I know, since Balss compiled his list, the following species have been described:

G. biungiculata Miyake, 1953 (? = *G. gardineri* Laurie)
G. bolivari Zariquiey, 1950
G. gardineri Laurie, 1926
G. inflata Potts, 1915
G. longirostris Yokoya, 1936 (preoccupied by *G. longirostris* Dana, 1852)
G. mauritiana Bouvier, 1915
G. minuta Potts, 1915
G. platycheles Miyake, 1953
G. providentia Laurie, 1926
G. serrirostris Melin, 1939 (? = *G. pusilla* Henderson)

G. submagnifica Laurie, 1926
G. ternatensis Melin, 1939
G. tridentirostris Miyake, 1953

KEY TO THE DETERMINATION OF THE INDIAN OCEAN SPECIES OF GENUS GALATHEA FABR.

I. Rostrum with one lateral spine . . . . . *G. pusilla* Henderson
II. Rostrum with more than one lateral spine.
A. Rostrum with three lateral spines.
I. Second abdominal tergum with one transverse groove.
A. Striae on carapace broken into squamiform scales.
1. All striae of carapace broken . . . . . *G. gardineri* Laurie
2. Only anterior striae broken.
a. All striae anterior to cervical groove broken . . . . . *G. aculeate* Haswell
b. Third anterior stria and some lateral ones broken . . . . *G. spinosorostris* Dana
B. Striae of carapace more or less continuous.
1. One pair of gastric spines only, hepatic spines absent . . . . . *G. orientalis* Stimpson
2. Two pairs of gastric spines, one pair of hepatic spines . . *? G. whiteleggei* Grant and McCulloch
II. Second abdominal tergum with three transverse grooves.
A. Several spines present on anterior and lateral surface of carapace . . *G. pubescense* Stimpson
B. Only one pair of gastric spines present . . . . . *G. cymbulaerostris* n. sp.
B. Rostrum with seven small lateral teeth . . . . . *G. elegans* Adams and White

Galathea pusilla Henderson

(Fig. 1*A–C*)

Galathea pusilla Henderson, 1885, p. 407.
Galathea pusilla, Henderson, 1888, p. 121, pl. xii, figs. 1, 1a and b ; Thomson, 1898, p. 193, pl. xxi, fig. 7 ; Whitelegge, 1900, p. 185 ; Grant and McCulloch, 1906, p. 49, pl. iv, figs. 5, 5a.
? *Galathea serrirostris* Melin, 1939, p. 72, figs. 43–47.

OCCURRENCE : *Red Sea :* St. 10, otter trawl, 55 metres, 1 male (c.l. + r. = 2·5 mm.), 4 females (c.l. + r. slightly over 2–3 mm.), chelipeds and legs missing.

DISTRIBUTION : Australia : Off Twofold Bay ; Off Bondi (New South Wales) ; Mast Head Islands (Queensland) ; New Zealand : Cook Strait Cable, Waganui, Peterson Inlet ; ? Japan : Bonin Island.

DESCRIPTIVE REMARKS : *Galathea pusilla* is known from several specimens, all of which came from the Pacific. As far as I am aware the " John Murray " specimens are the first to be recorded from the Indian Ocean. They are rather small, measuring from two to three mm. in carapace length, including the rostrum. Two of the bigger females are ovigerous. The carapace of an ovigerous female is illustrated in Fig. 1*A*. The pattern of striae is more or less constant in all the specimens. In the type Henderson described two pairs of spines on the gastric region. Thomson's specimens also had the same number of gastric spines, but the specimens described by Grant and McCulloch and, according to them, those taken by the " Thetis " had only a single pair of spines on the gastric region. In all the " John Murray " specimens this region is armed with five spines arranged in a more or less convex row ; the median spine is larger than the others. The type of *G. pusilla* is present in the British Museum (Nat. Hist.) and was available for study but unfortunately the gastric

region is mutilated and it is not possible to count the spines. In the type specimen the lateral margins of the rostrum are convex whereas in the " John Murray " specimens the rostrum is more triangular and the basal rostral spines are much larger.

The antennule and the merus of the third maxilliped are illustrated in Fig. 1*B* and *C*.

The chelipeds and legs of all the specimens are missing.

The single male specimen is small and in rather poor condition. As far as could be seen only the second pair of pleopods is present, and the endopods are slender with rather long setae fringing its posterior margin.

Remarks : The Indian Ocean specimens differ from the type in having a triangular rostrum, larger basal rostral spines and an extra spine on the gastric region. The spine on the inner margin of the third maxilliped is also somewhat more proximally placed.

Melin (1939, p. 72) referred several specimens collected from Bonin Island to *G. serrirostris* n. sp. A male specimen from Port Lloyd was very kindly sent to me on loan by the authorities of the Naturhistoriska Riksmuseet, Stockholm. The specimen had the tip of its rostrum bent, the right spine at the base of rostrum wanting and the gastric spines much smaller than figured by Melin (1939, fig. 43). On the whole the specimen showed a great resemblance to Henderson's species except that the anterior striae of the carapace were almost continuous. The chelipeds were short and stout measuring about twice the length of the carapace, including rostrum. The merus of the third maxilliped agreed with that of the type of *G. pusilla*. With only one specimen available it is somewhat difficult to ascertain the exact systematic position of *G. serrirostris*.

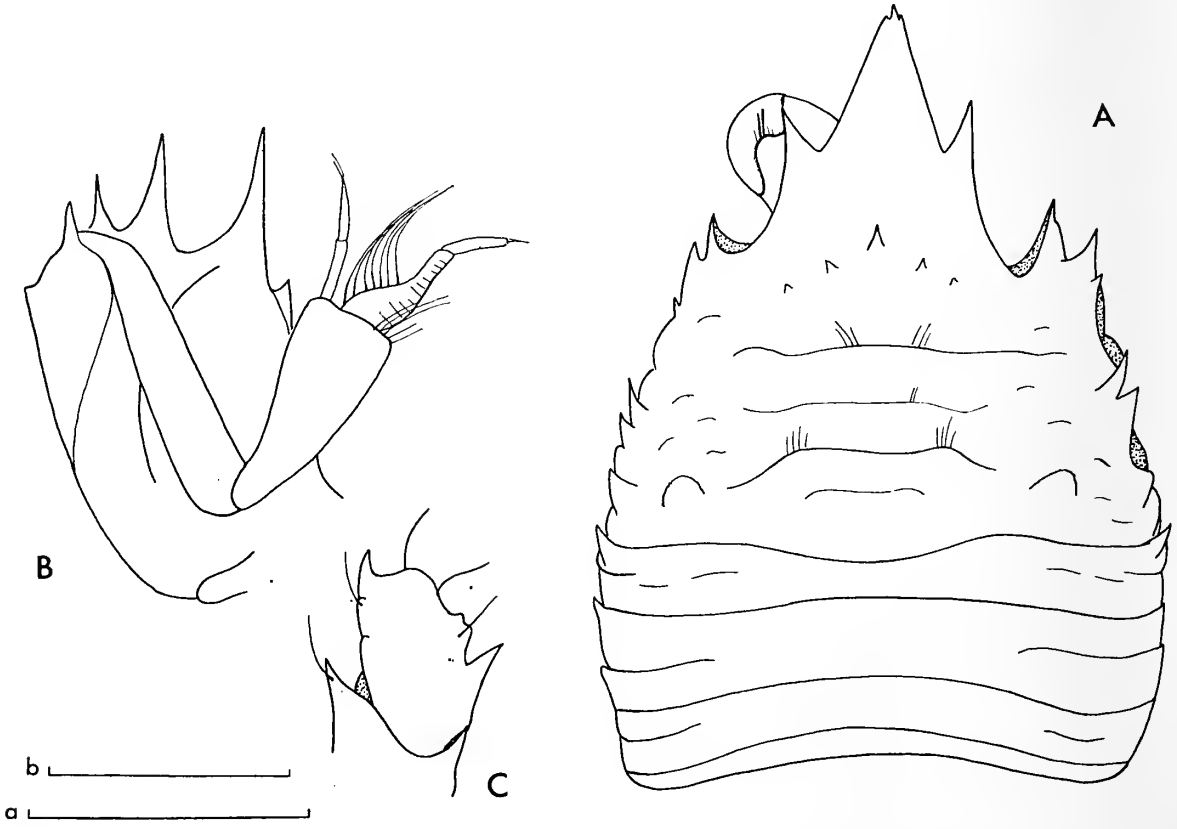


Fig. 1. *Galathea pusilla* Henderson. A. Carapace of female, dorsal view (scale *b* = 1 mm.). B. Right antennule, dorsal view (scale *a* = 0·5 mm.). C. Middle part of right third maxilliped (scale *a*).

Galathea gardineri Laurie

(Fig. 2)

Galathea gardineri Laurie, 1926, p. 131, pl. 9, figs. 1–5.
? *Galathea biungiculata* Miyake, 1953, p. 199, figs. 1 and 2.

Occurrence : St. B, rectangular dredge, 16 fathoms, 2 males (c.l. + r. = 4–4·5 mm., ch.l. = 8–9 mm.). [Data on label insufficient, could be St. M.B. I (b), 29 meters.]

Red Sea : St. 9, otter trawl, 30 fathoms, 2 females (c.l. + r. = 5 mm., ch.l. = 10 mm.). [In published station list only triangular dredge 4 and 245 meters are given.]

St. 10, otter trawl, 55 metres, 2 males (c.l. + r. = 3·5–5·5 mm., no chelip.), 4 females (c.l. + r. = 4–4·5 mm.).

Distribution : Indian Ocean, ? Japan.

Remarks on material : One of the two females from St. 9 is ovigerous, the chelae are slightly unequal measuring 10 mm. in length. The other female is infested by some species of Rhizocephala, its chelipeds are unequal. The left chela is heavier and 10 mm. in length, the other is slender and reaches only to the distal margin of the palm of the other chela. Of the four females taken at St. 10,

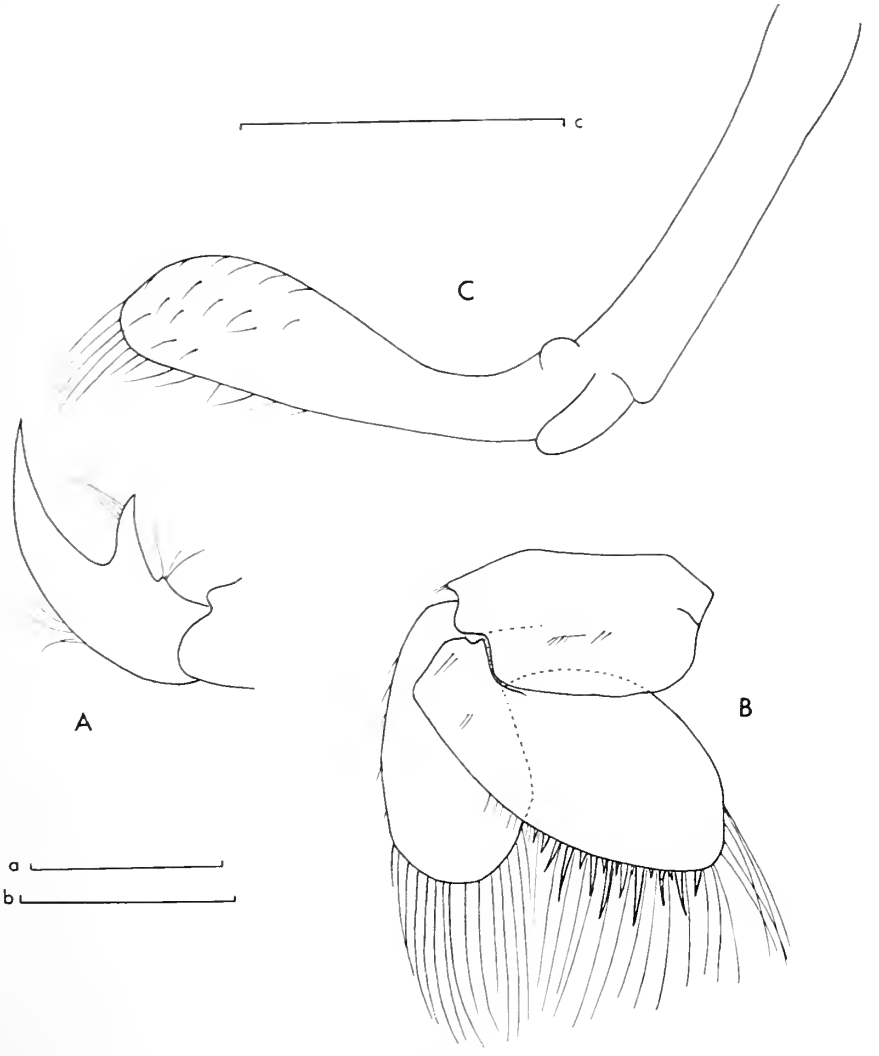


Fig. 2. *Galathea gardineri* Laurie. A. Dactylus of walking leg (scale *a* = 0·5 mm.). B. Left uropod, dorsal view (scale *b* = 1 mm.). C. Left second pleopod of male, dorsal view (scale *c* = 0·25 mm.).

only one, measuring 4 mm. in carapace length, including rostrum, is non-ovigerous, and the chelipeds measure 8 mm. in length ; all the others are ovigerous and the chelipeds are not attached to the body.

Descriptive notes : This species was established by Laurie in 1926 for two males and one ovigerous female collected from the Indian Ocean. The largest specimen was the female measuring 4 mm. in carapace length. The " John Murray " material consists of four males and six females and the largest specimen present is a male with the carapace 5·5 mm. long. All these specimens agree rather well with the original descriptions and figures. The few differences noticed are probably due to individual variations, since the specimens at hand also show some differences particularly in the density of hairs on body and limbs and also in the spinosity of the dorsum. Some of the older specimens are densely setose and most of the broken striae of the carapace are tipped with spinules while in the youngest specimen the hairs are scanty and only the anterior and lateral striae of the carapace have spinules. Furthermore, Laurie had observed four spinules on the posterior border of the carapace of the female ; this appears to be a variable character because in the " John Murray " specimens the posterior border is spinose in the largest male and in only one ovigerous female (c.l. + r. = 4·5 mm.).

The dactylus of a walking leg is illustrated in Fig. 2*A*. As can be seen it is very characteristic, terminating in a strong claw proximal to which is a strong spine with a small setose tubercle at its base.

The uropods are particularly interesting in having an elongate and laterally directed sympod (Fig. 2*B*). The endopod is partly flexed underneath the sympod, so that its lateral margin becomes posterior in natural position. Furthermore, this posteriorly directed margin of the endopod has stout, flexible, spine-like setae in addition to the normal ones.

As in *G. pusilla* the first pair of pleopods are absent in the male. The second pair of pleopods of the present species shows a striking resemblance to that of *G. pusilla*. The left pleopod of *G. gardineri* is represented in Fig. 2*C*.

Remarks : *G. biungiculata* was described by Miyake (1953) for one ovigerous female and according to him the specimen differed from *G. gardineri* in the armature of chelipeds and carapace. But, as shown above, the specimens are liable to individual variation as far as the spines of the dorsum are concerned. Further, Miyake (1953, p. 202) points out that his specimen " . . . is provided with five spines on the inner margin of the merus of the second ambulatory leg instead of no spines as in the case of *G. gardineri* ". Laurie's (1926, p. 133) descriptions of the meri of the ambulatory legs runs as follows: " The lower margin of the merus bears spines throughout its length in the 1st walking leg but only on the distal portion in the 2nd and 3rd." The " John Murray " specimens agree with the description given by Laurie in having the lower margin of the merus of the first leg spinose, the meri of the second and third legs are spinose distally but the rest of the margin is very strongly serrated. On the whole the two species are so near to each other that it is highly probable that with more information on the variation they might be put together. The only difference I can see between the two species is that in Miyake's (1953, fig. 2, c 3) specimen the inner margin of the third leg is unarmed whereas in the Indian Ocean specimens it has a few distal spines.

Galathea aculeata Haswell

(Figs. 3*A*, *B* and 4*A*)

Galathea aculeata Haswell, 1882, p. 761.
Galathea aculeata, Haswell, 1882, p. 162 ; Whitelegge, 1900, p. 190 ; Grant and McCulloch, 1906, p. 48, pl. iv, figs. 4, 4a.
Not *Galathea aculeata*, Henderson, 1888, p. 120.

Occurrence : St. B, rectangular dredge, 16 fathoms, 1 male (c.l. + r. = 7 mm., ch.l. = 15 mm.), 1 ovig. female (c.l. + r. = 6 mm., ch.l. = 13 mm.) [data incomplete].

Red Sea : St. 9, otter trawl, 30 fathoms, 2 females (c.l. + r. = 4–5 mm., ch.l. = 11 mm., detached), larger female ovig. [In published station list only triangular dredge 4 and 245 metres are given.]

Distribution : Australia : Holborn Island and Port Molle.

Descriptive remarks : The observations of Whitelegge (1900) and Grant and McCulloch (1906) were based on Haswell's type material ; all three authors questioned the identity of the " Challenger " specimens with the Australian species. On re-examining the " Challenger " specimens in the British Museum (Nat. Hist.) collection I can confirm that they certainly do not belong to *G. aculeata* Haswell. On the other hand, the " John Murray " specimens listed above do seem to be referable to *G. aculeata*. This, therefore, is the first authentic record of the species from the Indian Ocean.

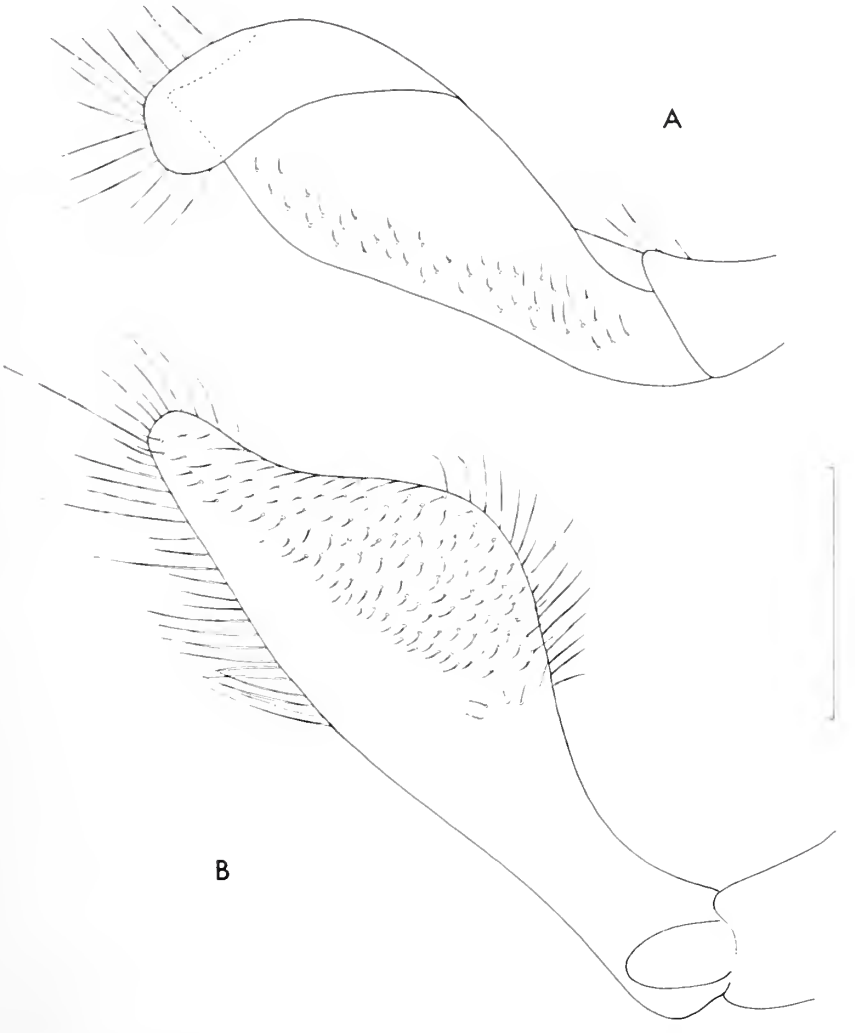


Fig. 3. *Galathea aculeata* Haswell, male. A. Endopod of left first pleopod, dorsal view. B. Distal part of left second pleopod, ventral view. (Scale = 0·25 mm.)

In the " John Murray " specimens the anterior squamiform striae are not only fringed with hairs but some of them are also tipped with spinules. Moreover, the rostral spines are acute, slender and deeply incised.

The basal segment of the antennule has three spines distally, which are more or less sub-equal in length and the outer ones are directed somewhat laterally.

According to Grant and McCulloch (1906, p. 49) the merus of the third maxilliped " . . . has two prominent spines on its inner margin and its outer margin is trispinose ". The merus of the third maxilliped of the male is illustrated in Fig. 4*A* ; it agrees with the above description except that the median spine on the outer margin is bifurcate. It may also be pointed out here that the armature of this margin is much weaker in all the other " John Murray " specimens which are all females.

Describing the chela Grant and McCulloch say that " The hand of the female is equal in length to the carapace, and is as long as the rest of the limb. Dactylus much longer than the palm." (p. 49). The present specimens agree with the type in having the chela as long as the carapace but in all instances the rest of the limb exceeds the palm by 1 mm. Moreover, the relative length of the dactylus and palm is also variable : in the female from St. B the dactylus is as long as the palm but in the male it is shorter than the palm. A detached cheliped is present in the same tube which contains two females taken from St. 9. In this cheliped, which I think must belong to the larger female, the dactylus exceeds the length of the palm by only 0·5 mm. In the male, on the other hand, the dactylus falls short by 1 mm.

In the male the first pair of pleopods is also present. The dorsal view of the first left endopod and ventral view of that of the second are illustrated in Figs. 3*A* and 3*B*.

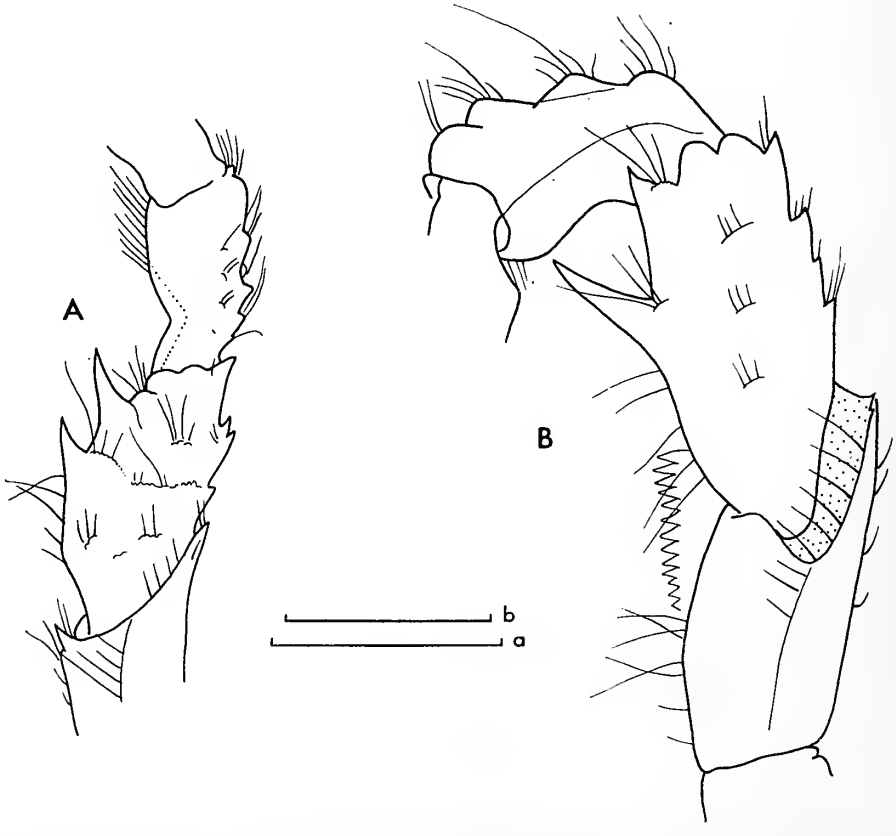


FIG. 4. *Galathea aculeata* Haswell : A. Part of left third maxilliped (scale *a* = 1 mm.). *Galathea spinosorostris* Dana : B. Ischium, merus and carpus of left third maxilliped (scale *b* = 0·5 mm.).

Galathea spinosorostris Dana

(Figs. 4*B* and 5)

Galathea spinosorostris Dana, 1852, p. 480.
Galathea spinosorostris, Dana, 1855, pl. 30, fig. 9 ; Lenz, 1910, p. 566 ; Laurie, 1926, p. 124 ; Miers, 1884, p. 560.
Munida spinulifera Miers, Southwell, 1909, p. 121, pl., fig. 12.

Occurrence : *Zanzibar area :* St. 111, Agassiz trawl, 73–165 metres, 1 female (c.l. + r. = 5·5 mm., ch.l. = 13·5 mm.).

Distribution : Indo-Pacific.

Descriptive remarks : The " John Murray " material of *G. spinosorostris* consists of a single female. The carapace is illustrated in Fig. 5. In general it agrees with Southwell's figure in the pattern of striae but differs mainly in having an oblique frontal margin which is armed with a slender spine. Moreover, a pair of gastric spines is also present which is neither shown in Southwell's figure nor mentioned by Laurie. They are quite evident in Dana's figure (1855, pl. 30, fig. 9a).

The basal segment of the antennule has three distal spines. The outer spine is slightly longer than the two sub-equal median spines, and it is also somewhat wider near the base.

The merus of the third maxilliped is shown in Fig. 4*B* ; as already pointed out by Laurie (p. 125) " . . . the distal tooth of the inner border of the merus is smaller than in Dana's figure ". The low

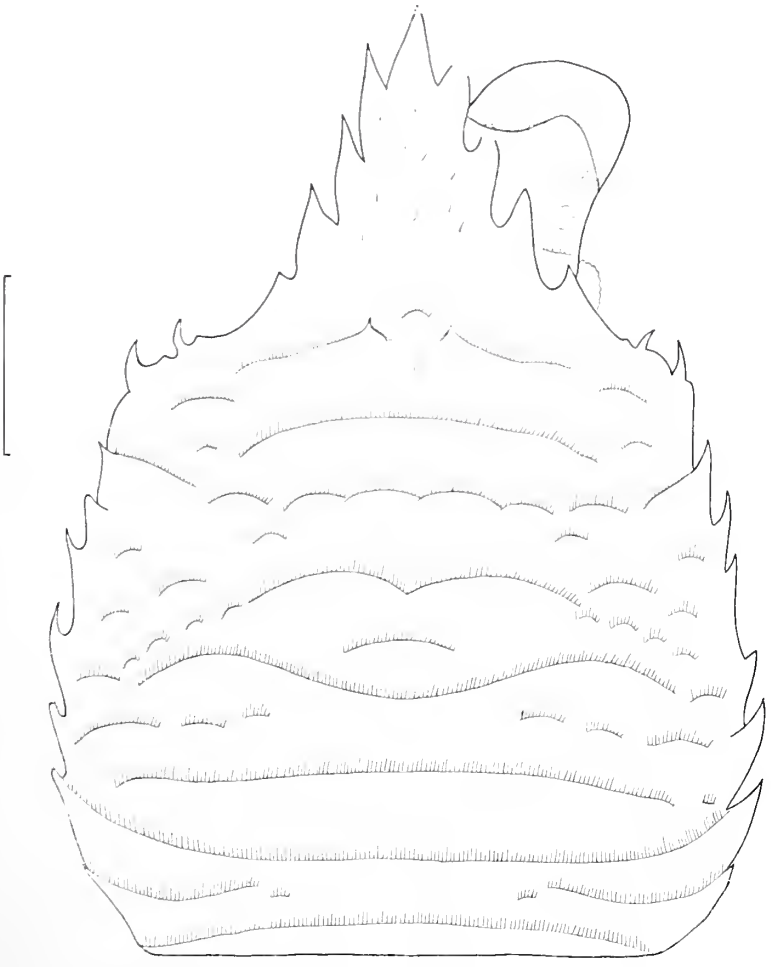


Fig. 5. *Galathea spinosorostris* Dana : Carapace, dorsal view (scale = 1 mm.).

rounded elevations on the outer border of the carpus, mentioned by Laurie, are quite prominent.

The chelipeds, as represented by Southwell (1909, pl., fig. 12), are long and slender. The fingers of the chela are as long as the palm and their inner margins are in contact throughout.

Galathea orientalis Stimpson

(Figs. 6 to 8)

Galathea orientalis Stimpson, 1858, p. 252.
Galathea orientalis, Stimpson, 1907, p. 231 ; Melin, 1939, p. 63, figs. 36–38 (also see for other references).

Occurrence : *Red Sea :* St. B, rectangular dredge, 16 fathoms, 3 specimens. [Data insufficient.]

South Arabian Sea : St. 43, otter trawl, 83–100 metres, 1 male.

St. 45, triangular dredge 4, 38 metres, several specimens.

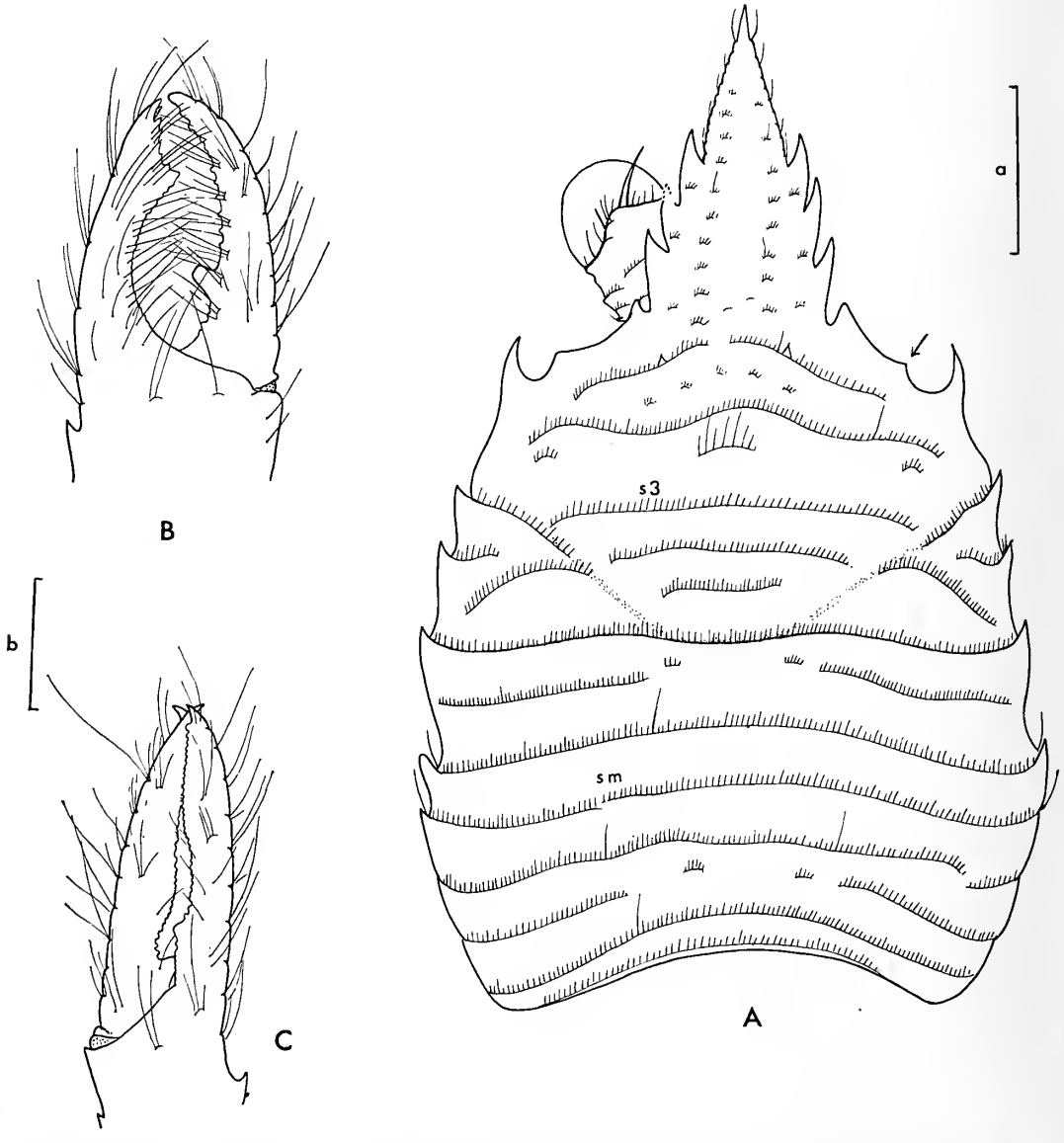


Fig. 6. *Galathea orientalis* Stimpson. A. Carapace of male, dorsal view ; *s3* third anterior stria, *sm* third postcephalic stria (scale *a* = 1 mm.). B. Left chela of older male (scale *b* = 1 mm.). C. Right chela of male (scale *b*).

Distribution : Hong Kong to Japan, and Bonin Island.

Remarks on material : The material consists of several specimens belonging to both sexes. The carapace length measures from 2·5 to 6·6 mm., including rostrum. The chelipeds of most specimens and the legs of almost all specimens are detached. The following are the measurements of those specimens which had the chelipeds attached :

Males : c.l. + r. = 6·5 mm., chelipeds unequal measuring 14 and 15 mm. in length ; c.l. + r. = 6·6 mm., ch.l. = 15 mm.

Females : c.l. + r. = 4, 5, 6 and 7·5 mm., ch.l. = 7, 11, 12 and 14 mm. respectively.

Descriptive notes : The carapace of a male is illustrated in Fig. 6*A*. The outer orbital angle (indicated by an arrow) is either acuminate as shown in the figure or it may be furnished with a slender spine. The antero-lateral spine is strong and is usually followed by four or five spines of which the last two are situated posterior to the cervical groove. The gastric region is armed with two small spines. In nearly all the specimens the setose striae of the carapace are as shown in Fig. 6*A* except in the youngest specimens where the stria labelled *sm* is not continuous in the middle being represented only at the sides of the carapace. Also, the precephalic striae *s3* is rather sinuous and not straight. The rostrum is long and pointed at the apex ; the first three lateral teeth are curved and deeply incised ; the dorsal surface of the rostrum is furnished with squamiform scales fringed with fine hairs. The second and the third abdominal tergum have each a slight transverse groove, the posterior margin of which is raised into a setose ridge. The remaining terga are smooth and without any sculpturing.

The eyes are rather characteristic especially in having hairs on the distal margin of the peduncle at least a few of which are remarkably stout and long.

The basal segment of the antennule has its distal margin armed with three sharp and laterally directed spines (Fig. 7*A*).

The basal segment of the antennal peduncle has its inner, distal angle produced into an acuminate, triangular process which may even exceed the distal margin of the third segment. The same angles of the two following segments are spinose. The outer, distal angle of the second segment is produced into a spine which scarcely reaches as far as the middle of the third segement.

In the third maxilliped the inner, distal angle of the ischium is produced into a spine which in some specimens may be very strongly developed (Fig. 8*A*). The armature of the merus varies quite considerably ; in the majority of specimens it is as represented in Fig. 7*B*, where the inner margin has two spines separated by a small tubercle and the outer margin has three spine-like projections. In a few specimens however, the merus has three spines on its inner margin (Fig. 8*A*). This variation does not seem to be related to the age or sex of the specimens. On the other hand, in all the specimens measuring from 2·5–4 mm. in carapace length (including rostrum) only the basal spine is developed, anterior to which are two sharp projections (Fig. 8*B*) ; the outer margin is almost smooth. The outer margin of the carpus, as far as I can see, is always without spines.

The chelipeds are long and slender. In the older males the left chela is heavier and the fingers are strongly curved (Figs. 6*B*, *C*). The two chelipeds are either equal or one of them may be slightly the longer. In the male from St. 43, where both the chelipeds are attached, the slender cheliped is the longer. All the ambulatory legs are detached, one of them is represented in Fig. 8*C*; the number of spines on the posterior margin of propodus vary from 4–6 and the anterior margin of the carpus is either spinose or strongly serrated.

Both the anterior and posterior margins of the endopod of the first male pleopod are curved as illustrated in Fig. 7*C*. The endopod of the second pleopod is flat and broad in some males but in some the dorsal surface is pushed downwards so as to form a gutter-like concavity on this surface—giving a slender and narrow appearance to the endopod (Fig. 7*D*).

Remarks : de Man (1907, p. 402) gave a detailed description of *G. acanthomera* from a male specimen from the Inland Sea of Japan and of Ortman's specimens of *G. orientalis* Stimpson which he redetermined as *G. acanthomera*. He also pointed out a few characters distinguishing this species from *G. orientalis*. The " John Murray " specimens, on the whole, seem to be referable to *G. orientalis* except that the dactylus of the chela has a single tooth instead of being bidentate and there are a few long hairs on the carapace and abdomen.

Melin (1939, p. 63) described specimens from Bonin Island as belonging to *G. orientalis* and mentioned that the specimens showed variation in the number of teeth present on the dactylus of the chela. Through the kindness of the authorities of the Naturhistoriska Riksmuseet, Stockholm, a few of Melin's specimens were available to me for comparison with the Indian Ocean material. The " John Murray " specimens agree rather well with them, specially in the number of spines on the lateral margin of the carapace and in the form of the rostrum, eyes, and chela (there was only one detached cheliped with a gaping chela). But they differ in having distinct setose scales on the rostrum, an anteriorly directed salient on the gastric region and three complete post-cephalic striae

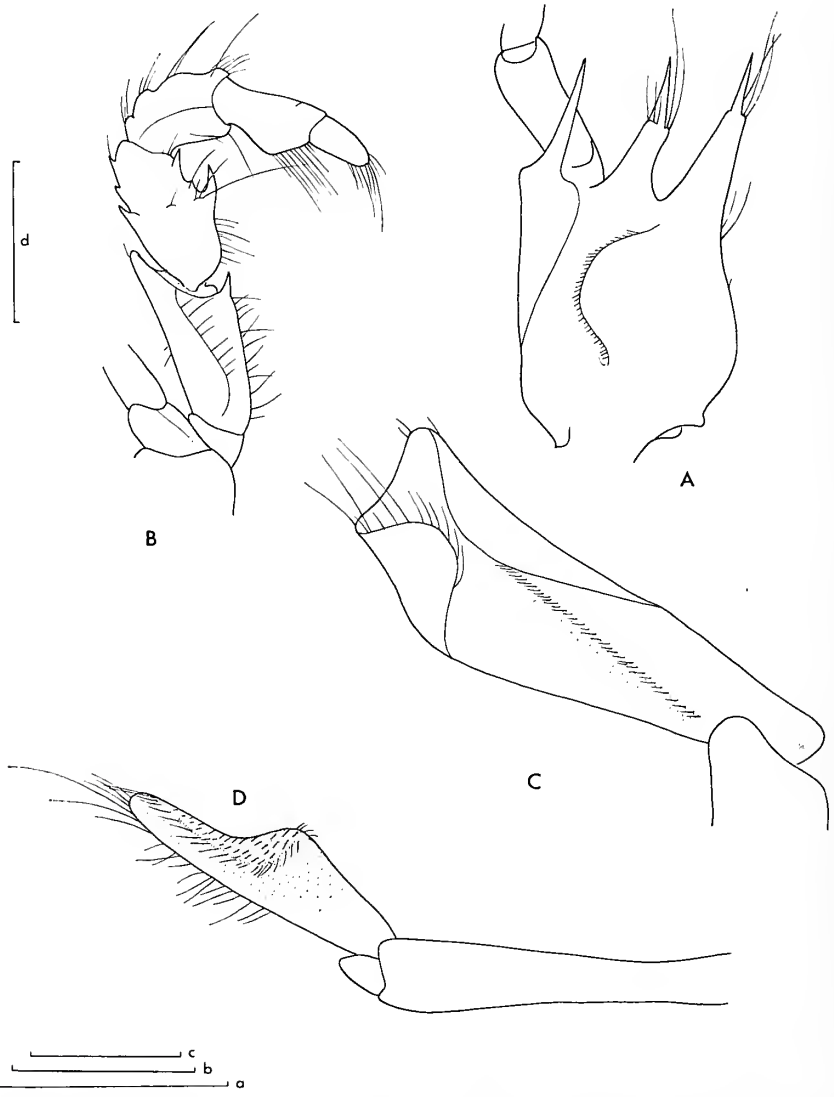


Fig. 7. *Galathea orientalis* Stimpson. A. Basal segment of right antennule, dorsal view (scale $c = 1$ mm.). B. Endopod of right third maxilliped (scale $d = 1$ mm.). C. Endopod of left first pleopod, dorsal view (scale $a = 0{\cdot}25$ mm.). D. Left second pleopod, ventral view (scale $b = 0{\cdot}5$ mm.).

in the majority of specimens. Moreover, the outer margin of the carpus of the third maxilliped appears to be without any distinct spines.

Though *G. acanthomera* and *G. orientalis* have been regarded as distinct species by several authors the features differentiating the two species are still insufficiently known.

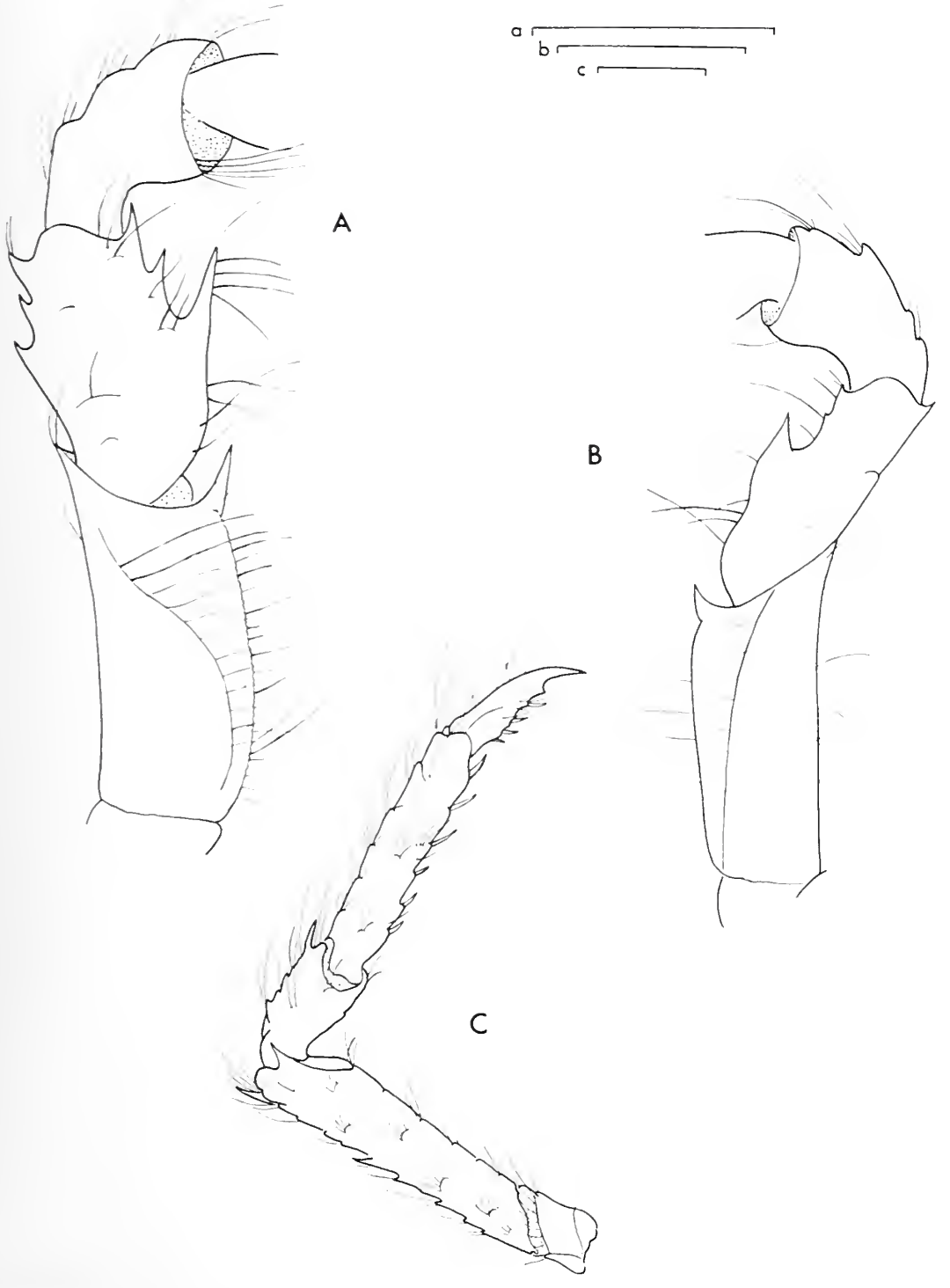


FIG. 8. *Galathea orientalis* Stimpson. A and B. Ischium, merus and carpus of third maxilliped from two specimens (A at scale *b*, B at scale *a* = 0·5 mm.). C. Ambulatory leg (scale *c* = 1 mm.).

Galathea whiteleggei Grant and McCulloch*

(Fig. 9)

Galathea sp. Whitelegge, 1900, p. 191.
Galathea whiteleggei Grant and McCulloch, 1906, p. 45, pl. iv, figs. 2, 2a.

Occurrence : *South Arabian coast :* St. 45, triangular dredge 4, 38 metres, 1 male (c.l. + r. = 7·5 mm., ch.l. = 18 and 17 mm.).

Distribution : Australia : New South Wales.

Descriptive notes : The anterior part of the carapace is represented in Fig. 9*A*. The striae of the carapace, posterior to the short stria labelled *sc* are very similar to those of *Galathea orientalis* (Fig. 6*A*) except that the third post-cervical (cf. Fig. 6*A*, *sm*) is represented in the middle third of the carapace by broken lines and the striae immediately anterior and posterior to it are not straight but somewhat sinuous. The gastric region has four spines and one spine is present on each hepatic area. The rostrum is long and acuminate, the dorsal surface is covered with numerous scales.

The dorsal surface of each of the second and third abdominal terga has a transverse groove, that of the fourth has a small groove near each lateral margin. The remaining two are smooth.

The basal segment of the antennule has three distal spines in most species of the genus.

The ischium, merus and the carpus of the third maxilliped are illustrated in Fig. 9*B*.

The chelipeds are long, spiny and slightly unequal, the left cheliped is one millimetre longer than the right. The fingers of the chela have acuminate tips and are only slightly shorter than the palm. None of the legs are attached, those present in the same tube have a spinosity very similar to those of *G. orientalis*.

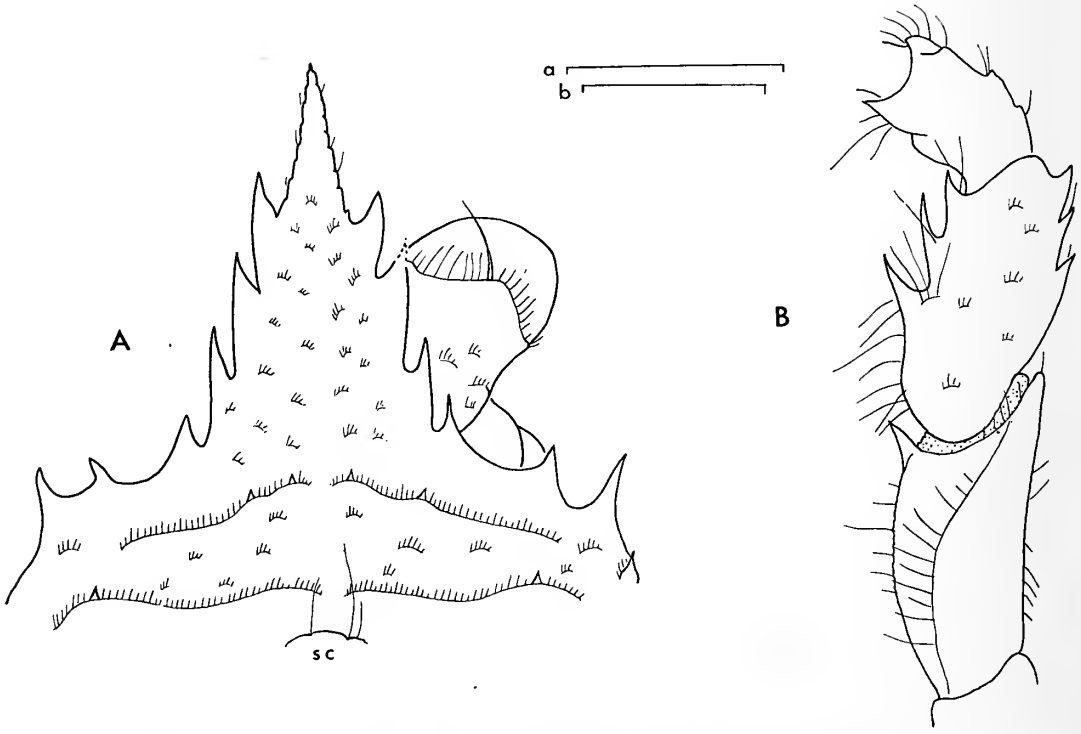


Fig. 9. ? *Galathea whiteleggei* Grant & McCulloch. A. Anterior part of carapace (scale *b* = 1 mm.) ; *sc*, short stria. B. Ischium, merus and carpus of left third maxilliped (scale *a* = 1 mm.).

* The spelling of the specific name should be "*whiteleggei*" since it is named after Whitelegge.

The first and second pleopods are also similar to those of *G. orientalis* except that the endopod of the second pleopod is flat and broad.

Remarks : In general the description of *G. whiteleggei* given by Grant and McCulloch applies well to the " John Murray " specimen except that the rostrum is not " . . . mesially grooved " (1906, p. 46) and an additional pair of gastric spines are present. Grant and McCulloch have not given any description of the abdominal terga ; in Fig. 2 (1906), however, there are two transverse grooves on each of the second and third terga. In the " John Murray " specimen there is only one transverse groove, which makes the identity of this specimen doubtful.

Galathea pubescens Stimpson

Galathea pubescens Stimpson, 1858, p. 252.
Galathea pubescens, Stimpson, 1907, p. 233 ; Balss, 1913 (a), p. 12, figs. 11, 12 ; Yokoya, 1933, p. 57 ; Miyake, 1957, p. 86.

Occurrence : *Zanzibar area :* St. 107, Agassiz trawl, 421–457 metres, 1 male (c.l. = 4 mm.).

Distribution : Japan.

Remarks : The " John Murray " specimen is imperfect : the rostrum is missing beyond the first pair of lateral spines, and the carapace is also incomplete posteriorly. The third maxillipeds are imperfect and neither the chelipeds nor any of the ambulatory legs are present except a fragment of one of the legs. As far as I can judge from the present condition of the specimen it belongs to *G. pubescens* and agrees with the descriptions and figure of the species given by Balss (1913, p. 12, fig. 11). Although Balss says : " Die Abdomen segmente tragen je vier Furchen, von denen die mittlere am tiefsten ist ", it is probable that " vier " is a misprint because his Fig. 11 shows only three grooves on the second and the third segments (as in the " John Murray " specimens).

In all essential features the first and second pair of pleopods are similar to those of *G. gardineri*.

Galathea cymbulaerostris n. sp.

(Fig. 10)

Occurrence : *South Arabian coast :* St. M.B. II (c), rectangular dredge, 29 metres, 1 male (c.l. + r. = 6 mm., ch.l. = 8 and 9 mm.). Register No. of holotype : 1966 · 2 · 4 : 46.

Description : The anterior part of the carapace is illustrated in Fig. 10*A*. The pattern of striae on the remaining surface of the carapace is very similar to that of *G. orientalis* except that here each stria has a faint groove posteriorly. The antero-lateral spine is strong and posterior to it there are seven spines on the lateral margin of the carapace. The rostrum is short and broad and on the concave dorsal surface there are a few minute scales ; the ventral surface has a median keel.

The first abdominal tergum has a transverse ridge, the second and third terga have each a wide median transverse groove and the two halves thus formed are again subdivided by narrower trans-

verse grooves. The tergum of each of the next two segments has additional small grooves. The last tergum has a setose ridge near the anterior margin and another some distance from it, the latter forms a wide " W " posterior to which is a smaller but shorter ridge.

The basal segment of the antennule is produced into three distal spines.

The inner margin of the merus of the third maxilliped has a single large spline and two rather sharp projections anterior to it (Fig. 10*B*).

The chelipeds are short, being only one and a half times as long as the carapace, and are fairly stout. The right cheliped is slightly longer than the left and is shown in Fig. 10*C*. The ambulatory legs are similar to those of *G. orientalis* in their spinosity.

The first and second pleopods are very similar to those of *G. whiteleggei*.

Relationship : In having a short and broad rostrum and three grooves on the second abdominal tergum this species is very near to *G. australiensis* Stimpson, from which it differs in having only one spine on the inner margin of the merus of the third maxilliped and much shorter chelipeds.

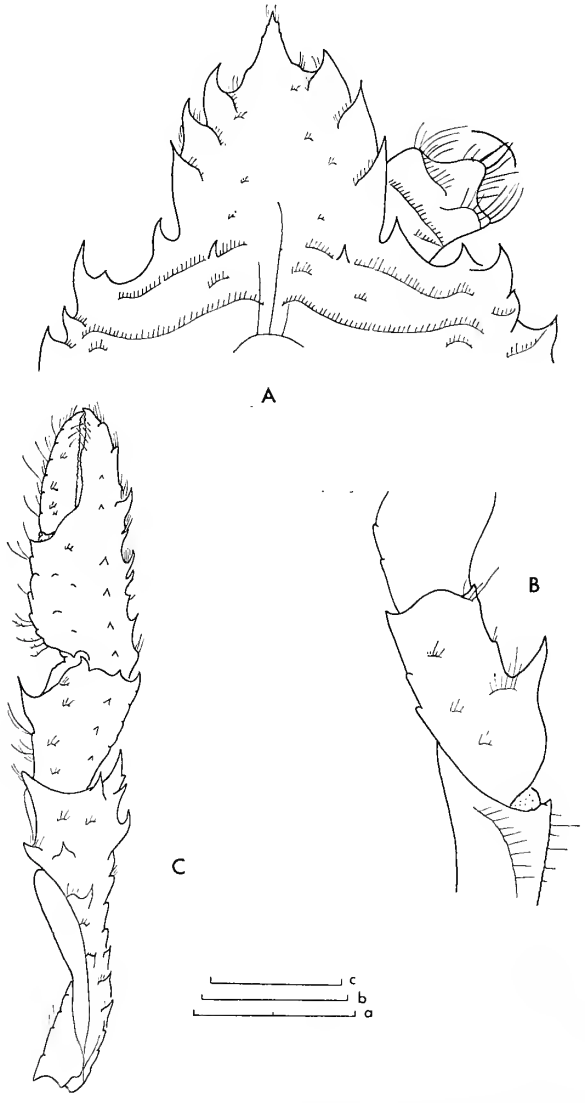


Fig. 10. *Galathea cybulaerostris* n. sp. A. Anterior part of carapace (scale $c = 1$ mm.). B. Merus of right third maxilliped (scale $b = 0{\cdot}5$ mm.). C. Right cheliped (scale $a = 2$ mm.).

Galathea elegans Adams and White

(Fig. 11)

Galathea elegans Adams and White, 1848, pl. XII, fig. 7.
Galathea elegans, Miers, 1884, p. 278 ; de Man, 1887, p. 455 ; 1902, p. 7 ; Walker, 1887, p. 112 ; Henderson, 1888, p. 117; 1893, p. 431 ; Ortman, 1894, p. 23 ; Borradaile, 1900, p. 421 ; Grant and McCulloch, 1906, p. 50 ; Southwell, 1906, p. 220 ; 1909, p. 120, fig. 11 ; Lenz, 1910, p. 566 ; Balss, 1913, p. 4 ; 1921, p. 22 ; 1924, p. 42 ; Potts, 1915, p. 83 ; Laurie, 1926, p. 133 ; Gordon, 1935, p. 7 ; Miyake, 1938, p. 37 ; Melin, 1939, p. 77, figs. 48–53 ; Barnard, 1947, p. 379 ; 1950, p. 487, fig. 91, i–k.
? *Galathea grandirostris* Stimpson, 1858, p. 252 ; Henderson, 1888, p. 119 ; Southwell, 1906, p. 221.

Occurrence : *Red Sea :* St. 9, otter trawl, 30 fath., 1 male (c.l. + r. = 10·5 mm., ch.l. = 18 mm.) [In published list triangular dredge 4 and 245 metres are given for St. 9.]

Distribution : Indo-Pacific.

Descriptive remarks : *G. elegans* is represented in the " John Murray " collection by a single male, measuring 10·5 mm. in carapace length. The rostrum is nearly as long as the carapace and is slightly depressed anteriorly. Barnard (1950, p. 488) states that the cervical groove is not continuous across the carapace. In the " John Murray " specimen the cervical groove is very distinct and stretches across the dorsum.

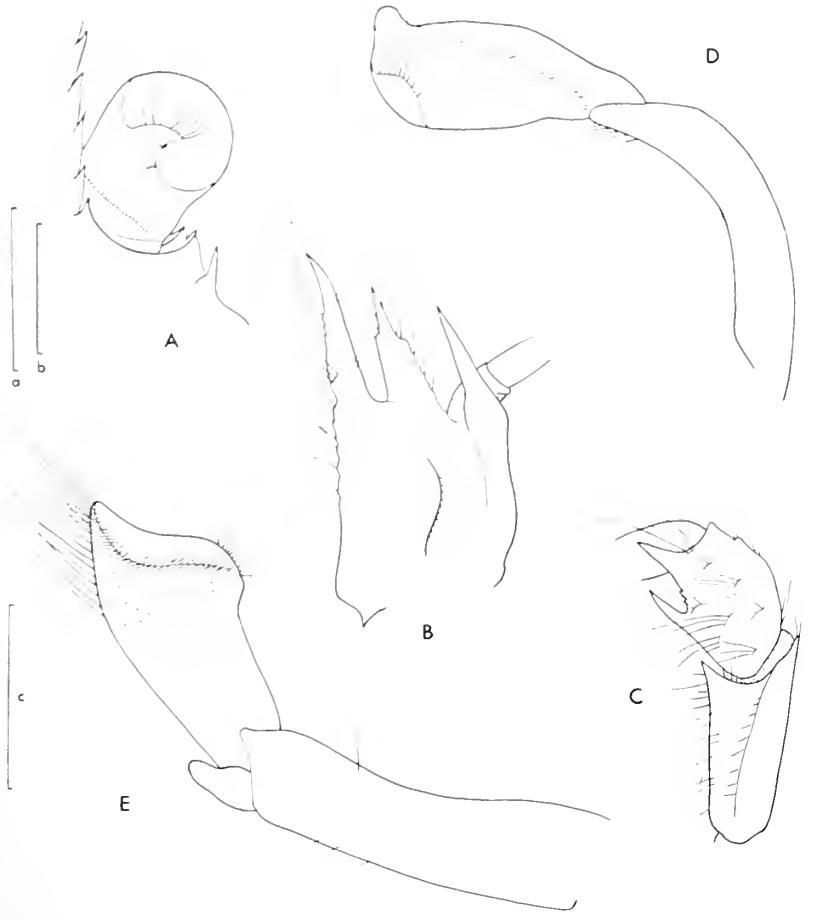


Fig. 11. *Galathea elegans* Adams & White, male. A. Right eye (scale *a* = 1 mm.). B. Basal segment of left antennule (scale *b* = 1 mm.). C. Ischium and merus of left third maxilliped (scale *a*). D. Left first pleopod, dorsal view (scale *c* = 0·5 mm.). E. Left second pleopod, ventral view (scale *c*).

The eye is rather characteristic in having over the cornea a beak-like prolongation of the stalk which is fringed with setae as represented in Fig. 11*A*.

The basal segment of the antennule has three spines distally (Fig. 11*B*) ; these spines are directed outwards, and become progressively longer from median to lateral.

The merus of the third maxilliped is shorter than the ischium, its inner margin is bispinose and the outer is only obscurely serrated (Fig. 11*C*).

The first and second pleopods are illustrated in Fig. 11*D* and *E*.

(For remarks on the synonymy see p. 174.)

Genus *MUNIDA* Leach

Chace (1942, p. 31) estimated that this genus comprises approximately 82 species ; of these Doflein and Balss (1919, p. 172) have tabulated 69 according to their known geographical and bathymetric distribution. As far as I know only one species and two sub-species have been described as new since the publication of Chace's paper ; they are : *M. kuboi* Yanagita 1949 ; *M. sarsi meridionalis* and *M. iris rutlanti* Zariquiey 1952.

Key to the determination of the Indian Ocean species of Genus Munida

I. Abdomen unarmed.
- I. Supra-orbital spines reaching as far as, or beyond, the outer border of cornea ; merus of third maxilliped with two spines on inner margin ; chelipeds about twice the length of carapace . ***M. elegantissima*** de Man
- II. Supra-orbital spines short, do not reach as far as the outer border of cornea ; merus of third maxilliped with three spines on inner margin ; chelipeds about three times the length of carapace . . ***M. roshanei*** n. sp.

II. Abdomen armed (except in one juvenile of ***M. japonica***).
- I. Only the second abdominal tergum with a row of spines on its anterior border.
  - A. Eyes small, not wider than their stalks ; chelipeds a little more than twice the length of carapace. ***M. microps*** Alcock
  - B. Eyes wider than their stalks ; chelipeds usually less than twice the length of carapace.
    - a. Eyes with a conspicuous fringe of " lashes "; about thirteen spines in the transverse gastric row ; a median, longitudinal row of two to three spines on gastric area . . . ***M. japonica*** Stimpson
    - b. Eyes generally without a conspicuous fringe of " lashes ", about eight spines in the transverse gastric row, no median gastric spines . . . . . ***M. andamanica*** Alcock
- II. More than one abdominal tergum armed.
  - A. The anterior margin of second tergum with a row of spines, same border of the third tergum with a pair of median spines ; chelipeds about two and a half times as long as the carapace . ***M. vigilarium*** Alcock
  - B. Second, third and fourth abdominal terga armed.
    - a. Anterior and posterior borders of the second, third and fourth terga armed ; carapace with a mid-dorsal row of spines ; posterior margin of carapace armed . . . . ***M. tricarinata*** Alcock
    - b. Only the anterior margin of second and third terga, and both margins of fourth tergum, armed. ***M. incerta*** Henderson

Munida elegantissima de Man

(Fig. 12)

Munida elegantissima de Man 1902, p. 726, pl. 24, fig. 42.
Munida elegantissima, Laurie, 1926, p. 138.
Munida alcocki Southwell 1906, p. 222, text-fig. 2.

Occurrence : *Zanzibar area :* St. 112, Peterson type, 113 metres, 1 male (c.l. + r. = 12·5 mm., ch.l. = 23 mm.) ; 1 ovig. female (c.l. + r. = 9 mm., ch.l. = 19 mm.).

Distribution : Indian Ocean.

Descriptive remarks : Both the " John Murray " specimens referred to this species agree rather well with the original description and figures given by de Man (1902). They differ from specimens described by Laurie (1926) in having the antero-lateral spines of the carapace directed inwards and also in possessing a single spine in the cervical triangle (Laurie's as well as Southwell's specimens

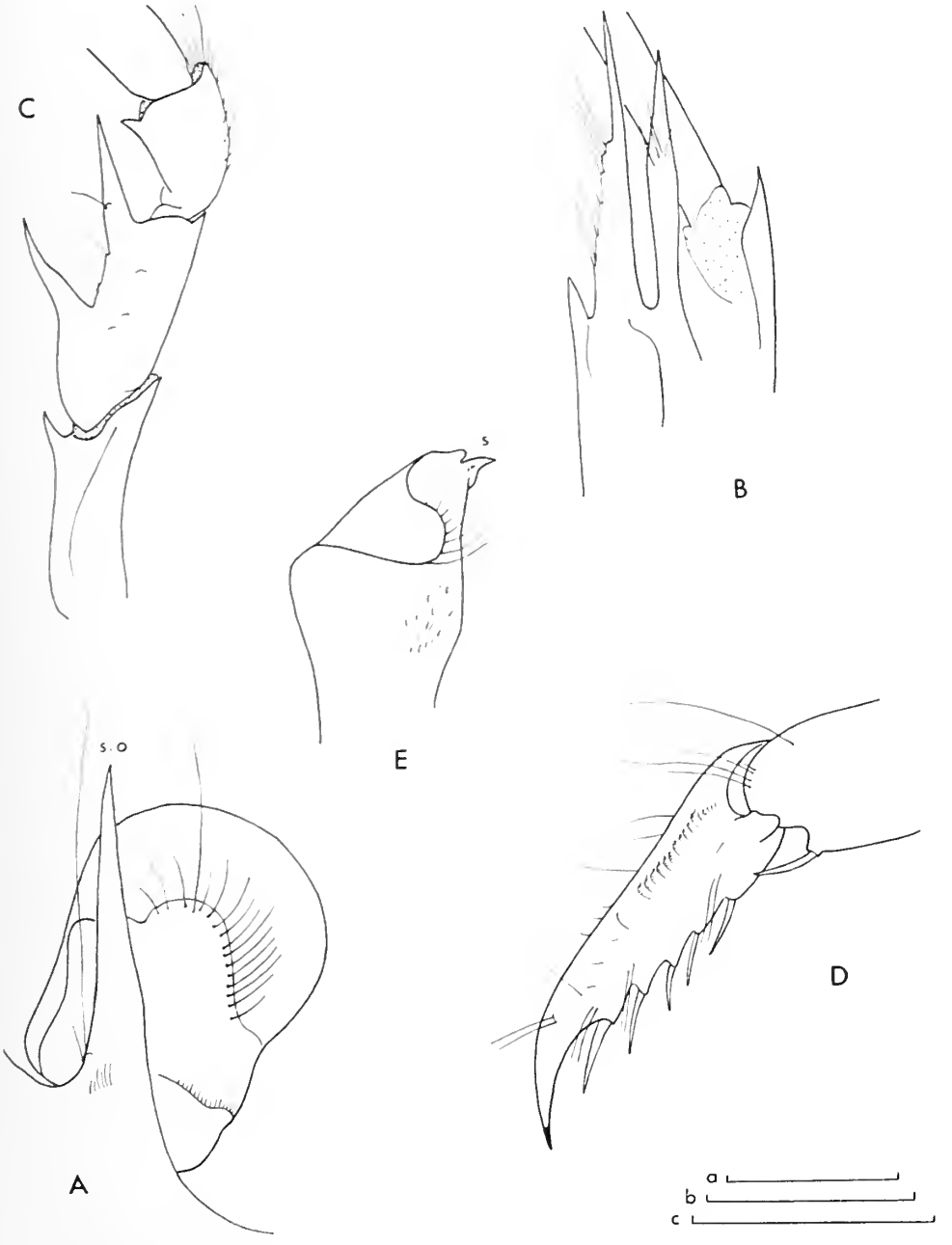


Fig. 12. *Munida elegantissima* de Man, male. A. Right eye and supra-orbital spine, *s.o.* (scale *a* = 1 mm.). B. Distal part of basal segment of right antennule, dorsal view (scale *b* = 1 mm.). C. Ischium, merus and carpus of left third maxilliped (scale *a*). D. Dactylus of left first ambulatory leg (scale *a*). E. Apex of left first pleopod (scale *c* = 0·5 mm.) ; *s* = spout.

had additional spines in this triangle). The supra-antennal spines are just a little shorter than the antero-lateral ones. In the male the supra-orbital spine extends beyond the cornea (Fig. 12*A*, *s.o.*); in the female it reaches only as far as the outer border of the cornea. The ocular peduncles are not so hairy in the " John Murray " specimens as illustrated by de Man (1902, pl. 24, fig. 42). There is a fringe of short hairs near the base of the peduncle and only in the female are there a few scattered hairs near the cornea.

The distal border of the basal segment of the antennule has four spines, two short and two long, as illustrated in Fig. 12*B*.

The ischium of the third maxilliped has a distal spine on its inner margin ; the merus has two strong spines on the same margin (Fig. 12*C*).

The chelipeds are long and slender as shown by de Man (1902, fig. 42*b*). The fingers of the chela are not quite twice the length of the palm. The posterior margin of the dactylus of each ambulatory leg is spinose and terminates in a strong claw (Fig. 12*D*).

The distal portion of the first pleopod of the male is represented in Fig. 12*E* ; as can be seen the apical margin, besides being curled and setose, is also produced into a sharp projection or spout (*s*), which in the natural position lies dorsal and posterior. The second pleopod resembles that of *M. microps* in having the central portion of the endopod broad and spinose, however, its apex is narrow and rounded.

Munida roshanei n. sp.

(Fig. 13)

Occurrence : *Gulf of Oman :* St. 71, otter trawl, 106 metres, 1 male (c.l. + r. = 7 mm., ch.l. = 21 mm.). Holotype. Register No. 1966 · 2 · 4 : 50

Gulf of Aden : St. 188, Agassiz trawl, 528 metres, 1 male (c.l. + r. = 7·5 mm., no chelipeds).

Description : The anterior part of the carapace is represented in Fig. 13*A*. The rostrum which is less than half the length of the carapace is slightly arched and bears a fairly strong mid-dorsal carina which, when viewed in profile, appears to be serrated. The supra-orbital spines are short, pointed and also carinate. The spine on the antero-lateral angle of the carapace is strongly developed and is followed by six lateral spines. In addition to the transverse row of spines on the gastric region there are also three small spines arranged longitudinally in line with the mid-dorsal carina of the rostrum. A pair of small lateral spines is present immediately behind the first continuous transverse stria of the gastric region. A spine is situated behind the anterior fork of the cervical groove and another spine behind the bifurcation of the cervical groove. The transverse striae of the carapace are all fringed with short setae interspersed with a few longer ones. The abdomen is unarmed. The second, third and fourth terga have each a median transverse groove and on each half thus formed are one or two finer grooves. The posterior margin of each groove is hairy. The anterior margins of these terga are also hairy with long hairs at regular intervals.

The eyes are slightly broader than the stalks and fringed with extremely fine setae (Fig. 13*A*).

The basal segment of the antennule has four spines arranged as shown in Fig. 13*B*. The basal segment of the antenna is produced at its antero-median angle into a sharp spine ; the antero-median and the antero-lateral angles of the following segment are produced into curved spines (Fig. 13*C*).

The inner margin of the merus of the third maxilliped is armed with three sub-equal spines (Fig. 13*D*).

The chelipeds are long and slender, being three times as long as the carapace. The inner margin of the merus, carpus and the palm is spiny and in addition there is a row of spines on the dorsal surface of these segments, median to the row on the inner margin. The entire surface of the cheliped is covered with setose scales some of which may be tipped with minute spines. The inner margin of the merus has a thick fringe of rather short hairs. The inner margin of the ischium is serrated and the outer distal angle is produced into a small curved spine. The great length of the cheliped is mainly due to the chela which exceeds half the length of the appendage (ch.l. = 21 mm., length of chela = 11 mm., length of fingers = 5 mm.). The fingers are not quite half the length of the palm, and their characteristic form is illustrated in Fig. 13*E*.

The first and second pair of pleopods are both present and show a strong resemblance to those of *M. japonica* (cf. Fig. 16) ; the second pair approaches more closely the adult form.

Relationship : In the form of the chela and the armature of the carapace, *M. roshanei* shows a close resemblance to *M. kuboi* Yanagita, from which it can easily be distinguished by the shorter

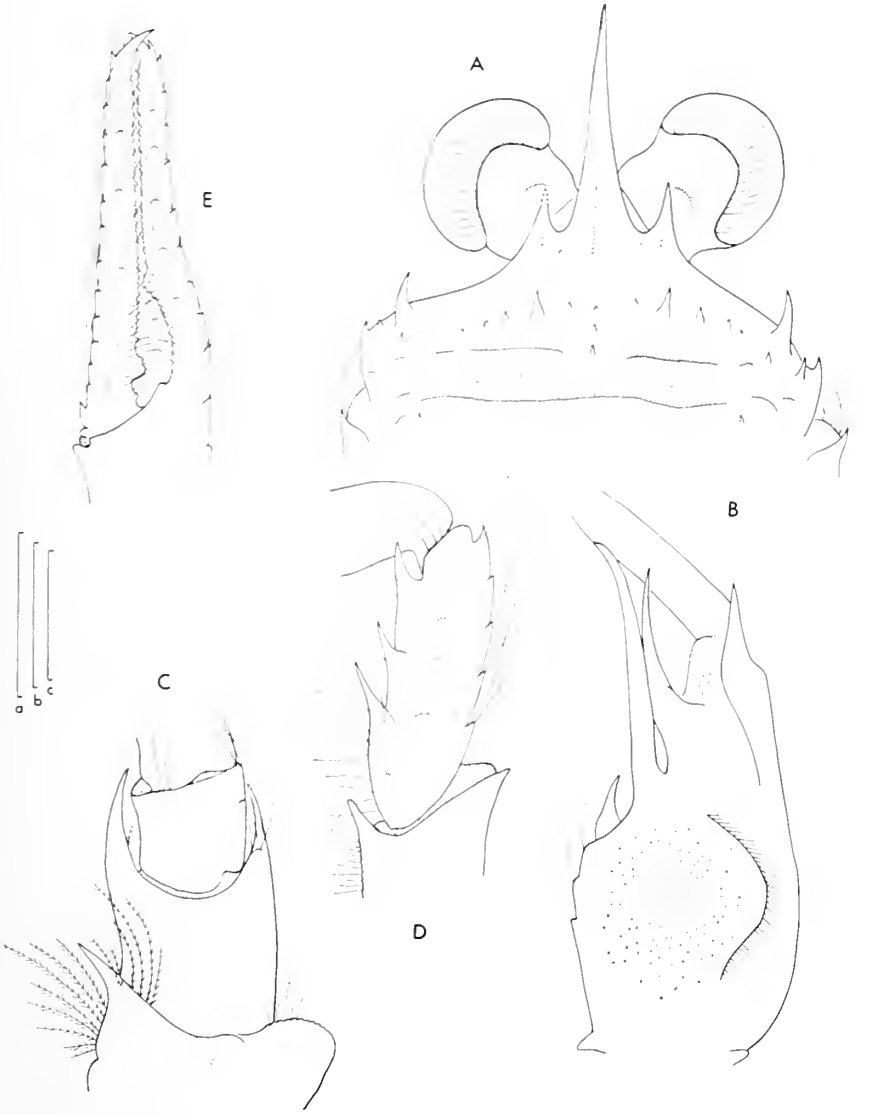


Fig. 13. *Munida roshanei* n. sp. A. Anterior part of carapace (scale *c* = 1 mm.). B. Basal segment of left antennule, dorsal view (scale *b* = 0·5 mm.). C. Basal segments of antennal peduncle (scale *b*). D. Middle part of left third maxilliped (scale *b*). E. Right chela (scale *a*).

chelipeds and the shorter fingers of the chela. In *M. kuboi* the chelipeds are four times as long as the carapace and the movable finger is two-thirds the length of the palm. Moreover, the abdomen in *M. roshanei* is unarmed and the merus of the third maxilliped has three spines on its inner margin—instead of two in *M. kuboi*.

Munida microps Alcock

(Fig. 14)

Munida microps Alcock, 1894, p. 326.
Munida microps, Alcock, 1901, p. 240, Ill. Zool. Investigator, Crust., pl. XIII, fig. 5.



FIG. 14. *Munida microps* Alcock, male. A. Distal part of basal segment of right antennule, dorsal view (scale $c = 1$ mm.). B. Merus of left third maxilliped (scale *c*). C. Left chela (scale $a = 1$ mm.). D. Endopod of left first pleopod, dorsal view (scale $b = 1$ mm.) ; *l*, curled anterior margin. E. Distal part of left second pleopod, ventral view (scale *b*) ; *sp.*, coiled sperm cord.

Occurrence : *Maldive area :* St. 158, Agassiz trawl, 686–1170 metres, 1 male (c.l. + r. = 20 mm., ch.l. = 41 mm.).

Distribution : Indian Ocean.

Descriptive remarks : In the " John Murray " specimen the gastric area is armed with ten spines, eight of which are arranged in a more or less transverse row, while the outer pair is further back on a level with the first transverse stria. The second pair of the gastric spines is the largest, the first and fourth pairs are quite small. Another pair of smaller spines is situated at the level of the third stria and in line with the last (outer) pair of spines just mentioned. As stated by Alcock " A spinule or two are found within the area enclosed by the bifurcation of the cervical groove." (1901, p. 240). In the " John Murray " specimen two spines are present in the right cervical triangle but only one on the left side. The anterior margin of the second abdominal tergum has ten spines, two more than the maximum number described in the types.

The basal segment of the antennule has four spines (Fig. 14*A*). The smallest is situated distally on the inner margin of the segment. The three spines on the outer margin are long and sharp, the central one is curved and directed upwards. The antennal spines are similar to those of *M. vigiliarum* (see p. 202).

The inner margin of the ischium of the third maxilliped ends distally in a small (? articulated) spine, while the same margin of the merus has a large proximal and a much smaller distal spine (Fig. 14*B*). The latter spine is hidden by the long hairs of the segment and can easily be overlooked (it was not mentioned by Alcock).

Alcock stated that the chelipeds are not equal in the males (1901, p. 241) ; in the " John Murray " specimen they are symmetrical. Their spines are long, sharp and curved. The merus and carpus each have three longitudinal rows of spines and the merus, in addition to these, has an outer row of much smaller spines. The palm of the chela is spinose on both its borders, the fingers are as represented in Fig. 14*C*. The next three pairs of legs are similar to those of *M. vigiliarum* as figured by Alcock (1901, pl. 13, fig. 5).

Fig. 14*D* represents the anterior view of the first pleopod, which has a setose lobe (*l*) near the apex. The second pleopod is represented in Fig. 14*E* ; a spermatic cord (*s*) is attached to the basal part of the endopod, and a similar but much coiled cord emerges from each genital opening.

Munida japonica Stimpson

(Figs. 15–16)

Munida japonica Stimpson, 1858, p. 252.
Munida japonica, Stimpson, 1907, p. 235 ; Miers, 1879, p. 51 ; Ortman, 1892, p. 254, pl. 11, fig. 11 ; Borradaile, 1900, p. 422 ; de Man, 1902, p. 724 ; Doflein, 1902, p. 644 ; Southwell, 1906, p. 221 ; Balss, 1913, p. 15, fig. 14 ; 1916, p. 3 ; Laurie, 1926, p. 135 ; Yokoya, 1933, p. 58 ; Melin, 1939, p. 85, figs. 54–57.
Munida japonica japonica Yanagita, 1943, p. 24, fig. 7.

Occurrence : *Red Sea :* St. 9, otter trawl, 30 fathoms, 1 male (c.l. + r. = 6 mm., ch.l. = 11 mm.) ; 2 females (c.l. + r. = about 11 mm., ch.l. = 18 mm.). [In published list only triangular dredge 4 and 245 metres are given.]

Zanzibar area : St. 106, Agassiz trawl, 183–194 metres, 2 males (c.l. + r. = more than 7–12 mm., ch.l. = 11·5–21 mm.) ; 1 female (c.l. + r. = 10 mm., ch.l. = 18 mm.).

DISTRIBUTION : Indo-Pacific.

DESCRIPTIVE NOTES : It has already been pointed out by earlier authors that this species exhibits a certain degree of variation in several of its characters. However, the six " John Murray " specimens, three males and three females, show differences which are not of any great significance.

The front part of the carapace of a female from St. 106 is illustrated in Fig. 15*A*. The rostrum, which is about half the length of the carapace is arched dorsally in the basal two-thirds, the remaining portion is finely serrated and the extreme tip is upturned. The supra-orbital spines are less than half the length of the rostrum and are arched over the eyes. The number of spines in the transverse gastric row is not constant. In both the females from St. 9 there is an extra spine median to the right large gastric spine (Fig. 15*A*, *s*). In the male from the same station the left large spine is bifurcated, and the last pair is missing reducing the number of spines in each half to five. Moreover, in the females from St. 9 there are three spines forming the median gastric row but in all others there are only two spines ; the last one may be represented by a scale.

The anterior margin of the second abdominal tergum is armed with 2–7 teeth. In the youngest male they are absent, in another small male from St. 106 they are only poorly developed.

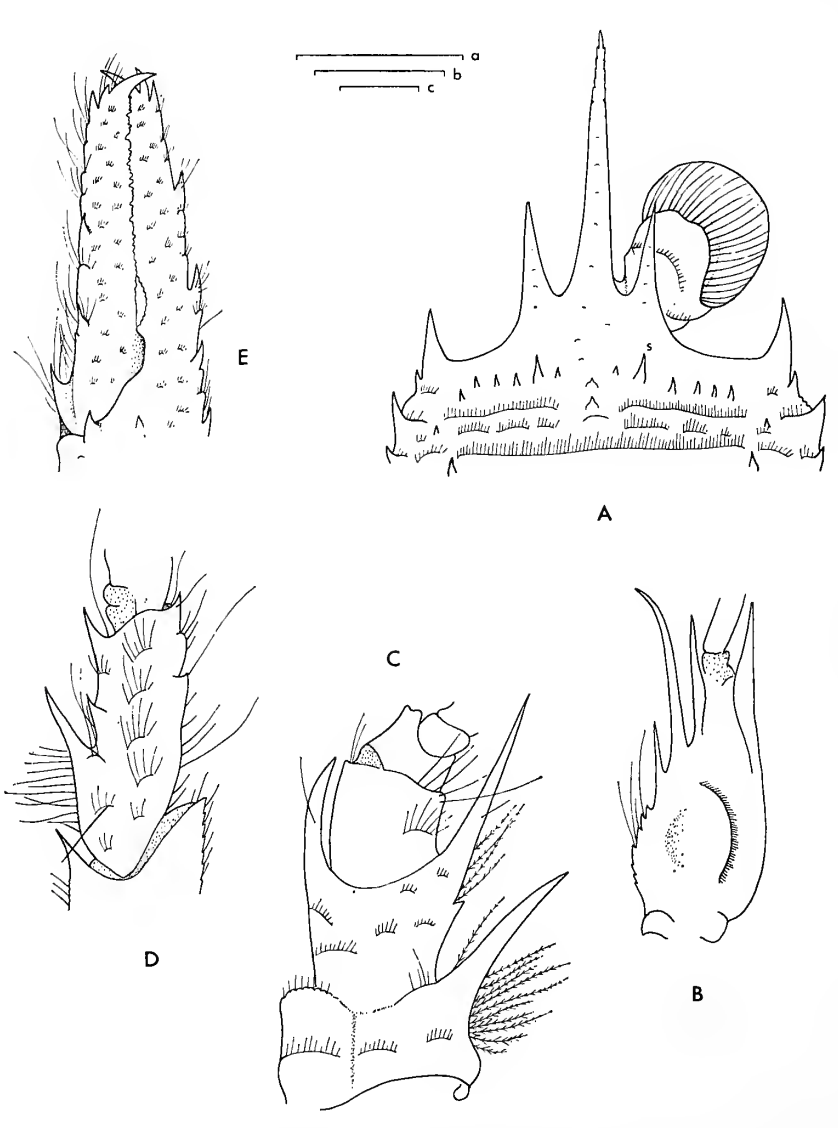


FIG. 15. *Munida japonica* Stimpson. A. Anterior part of carapace of female (scale *c* = 1 mm.). B. Basal segment of left antennule, dorsal view (scale *b* = 1 mm.). C. Left antennal peduncle, ventral view (scale *a* = 1 mm.). D. Merus of left third maxilliped (scale *a*). E. Right chela (scale *c*).

The eyes are characterized by a conspicuous fringe of " lashes " (Fig. 15*A*). The basal part of the antennule and antenna are shown in Fig. 15*B*, *C*. The merus of the third maxilliped is armed with three spines on the inner margin (Fig. 14*D*) ; the median spine may be developed or it may be represented by a tubercle.

The chelipeds are less than twice the length of the carapace, the fingers of the chela are only a little longer than the palm, their spinosity is as illustrated in Fig. 15*E*.

In the males both first and second pairs of pleopods are present. The endopod of the first pleopod is membranous, the anterior margin is setose and curled dorsally (Fig. 16*A*). Posteriorly, on the dorsal surface, is a fold or a thickening (*t*) which is bordered on the median side by stout curved setae. The endopod of the second pleopod is narrow, and boomerang-shaped, armed on the margins and ventral surface with spines as shown in Fig. 16*B*. In the younger male (c.l. + r. = 7 mm.—tip of rostrum broken) the pleopods show an early stage of development (Fig. 16*C*, *D*).

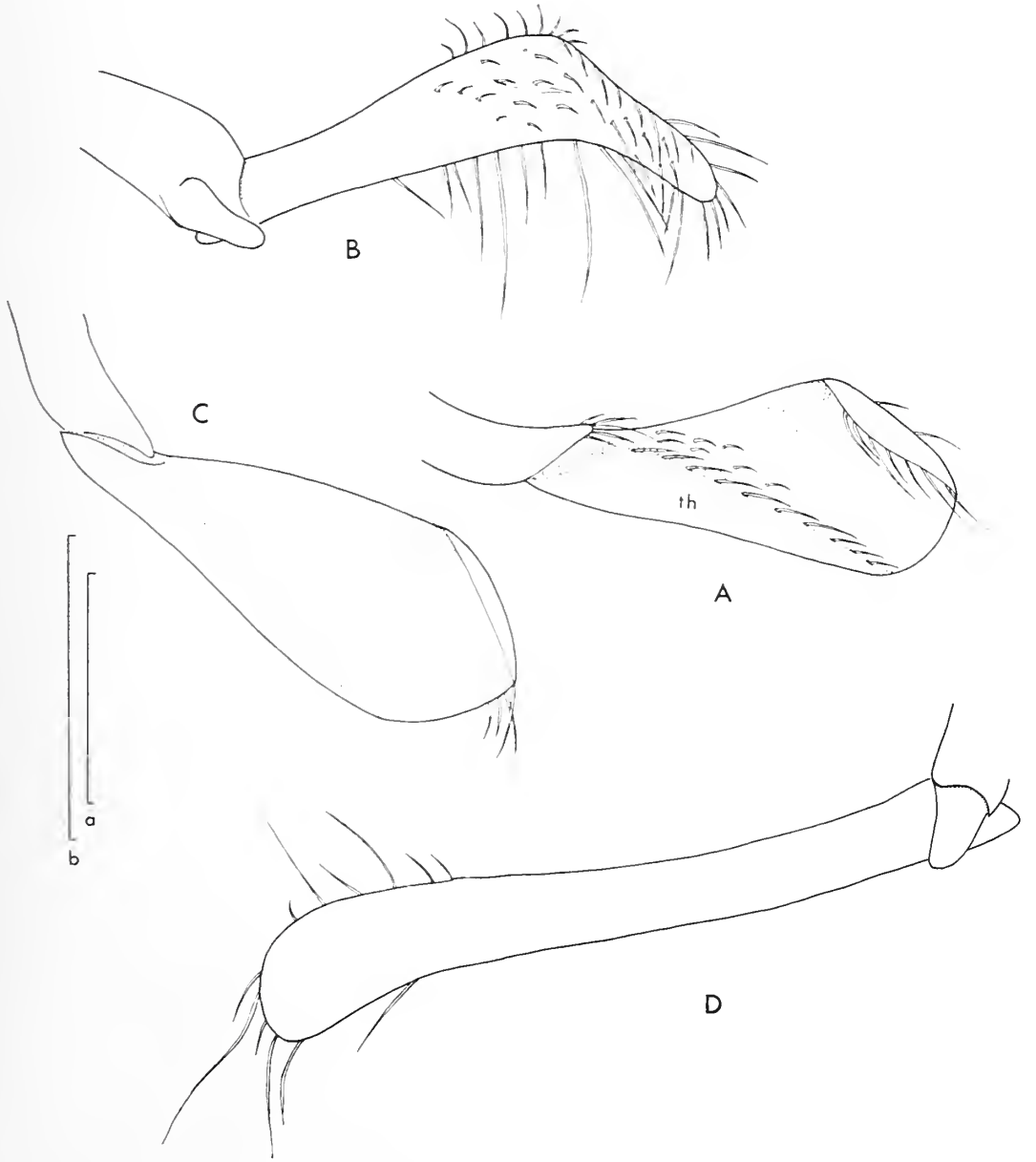


FIG. 16. *Munida japonica* Stimpson, male. A. Endopod of left first pleopod of adult, dorsal view (scale *a* = 0·5 mm.); *th*, thickening of fold on posterior dorsal surface. B. Distal part of right second pleopod of adult, ventral view (scale *a*). C and D. Distal part of left first and second pleopods of a young specimen (scale *b* = 0·25 mm.).

Munida andamanica Alcock

(Figs. 17–19)

Munida militaris var *andamanica* Alcock 1894, p. 321.
Munida militaris var *andamanica*, Boone, 1935, p. 42, pl. 10.
Munida andamanica Alcock, 1901, p. 242, Ill. Zool. Investigator Crust., pl. XII, fig. 2.
Munida andamanica, Kemp and Sewell, 1912, p. 25 ; Balss, 1913, p. 17 ; Doflein and Balss, 1913, p. 143 ; Yokoya, 1933, p. 63 ; Yanagita, 1943, p. 29.
Munida curvatura Benedict, 1902, p. 253.



FIG. 17. *Munida andamanica* Alcock. A. Dorsal view of female from St. 34 (scale *b* = 5 mm.). B. Dactylus of last ambulatory leg (scale *c* = 2 mm.). C. Anterior part of carapace of male from St. 188 (scale *a* = 2 mm.).

Occurrence : *Gulf of Aden :* St. 34, Agassiz trawl, 1022 metres, 8 males (c.l. + r. = 18·5–34 mm.) ; 9 females (c.l. + r. = 20–29 mm.).

St. 35, otter trawl, 457–549 metres, 1 male (c.l. = 13 mm., ch.l. = 33 mm.).

St. 188, Agassiz trawl, 528 metres, 1 male (c.l. = 7 mm., ch.l. = 16 mm.).

Zanzibar area : St. 109, Agassiz trawl, 640 metres, 1 male (c.l.+r.=20 mm., ch.l.=60·5 mm.).

Maldive area : St. 154, Agassiz trawl, 456 metres, 1 male (c.l.+r.=16·5 mm., ch.l.=24 mm.).

Remarks on material : Out of a total of twenty-one specimens in the " John Murray " collection twelve are males and nine females. The youngest is a male with the carapace measuring 7 mm., the largest is also a male, its carapace 22 mm. in length (not including rostrum). Most specimens do not have chelipeds attached, where present they measure less than twice the length of the carapace including rostrum, except in the male from St. 109 where they are about three times as long as the carapace. The largest detached cheliped from St. 34 is rather stout and is 75 mm. long. Only one female (c.l. + r. = 26 mm.) is ovigerous.

Descriptive remarks : The " John Murray " specimens agree fairly well with the original description of the species. It has already been shown by previous authors that their specimens differed slightly from the type in the spinosity of the carapace. A careful examination of the " John Murray " specimens showed that there is considerable variation not only in the number of spines on the carapace but also in the relative length of the antennular spines as well as in the number of spines present on the second segment of the antenna, merus of the third maxilliped, and the anterior margin of the second abdominal tergum, as given below :

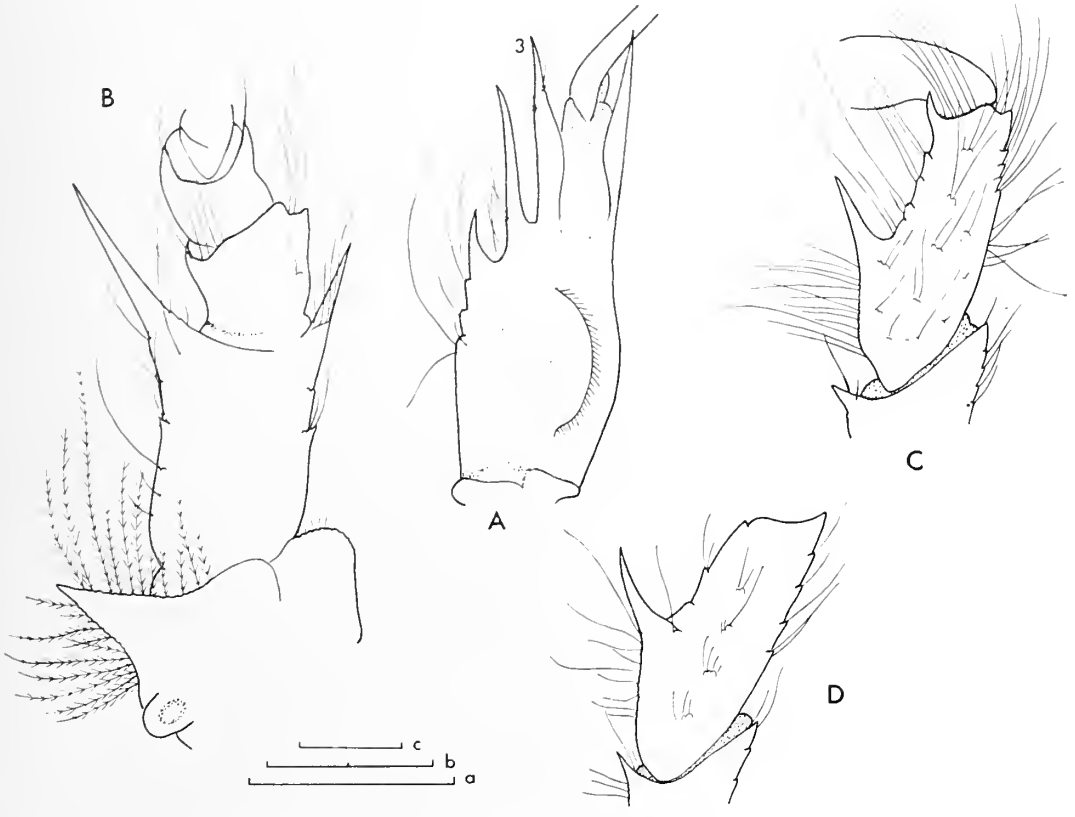


Fig. 18. *Munida andamanica* Alcock. A. Basal segment of left antennule of figured female from St. 34, dorsal view (scale *c* = 1 mm.). B. Left antennal peduncle of same, ventral view (scale *c*). C. Merus of left third maxilliped of same (scale *b* = 2 mm.). D. Merus of left third maxilliped of male from St. 188 (scale *a* = 1 mm.).

The carapace of a female is illustrated in Fig. 17*A*, a pair of small spines are present immediately behind the large gastric pair which are in line with the supra-orbital spines. These small spines are present in several specimens and may be quite conspicuous ; in some they may be represented by small tubercles or may be present only on one side or may be totally lacking. The spines behind the bifurcation of the cervical groove are always present but the pair of spines behind the anterior fork of the cervical groove are not always present ; they are wanting on several specimens and in another specimen only one is present. The anterior margin of the second abdominal tergum is furnished with seven to ten spines, those in the middle are usually larger than the lateral ones.

The eyes are large and globular but the conspicuous fringe of setae mentioned by Alcock (1901, p. 242) is not noticeable in all specimens.

The basal segment of the antennule is armed with four spines. In the majority of specimens the third spine (counting from the inner side—labelled 3 in Fig. 18*A*) is the longest, in some the second and third spines are sub-equal but in a very few specimens the second extends far beyond the third (2 in Fig. 19*A*). The basal segments of the antenna in most of the specimens are as represented in Fig. 18*B* but in some specimens the antero-median angle of the basal segment may be produced into a much larger spine and the inner margin of the next segment may have an additional spine or spines (Fig. 19*B*).

The inner margin of the merus of the third maxilliped is furnished with a much larger proximal and a smaller distal spine (Fig. 18*C*), a spine-like projection may be present between them (Fig. 19*C*). In the youngest male the merus has only the large proximal spine and the distal one is represented by a small projection as shown in Fig. 18*D*.

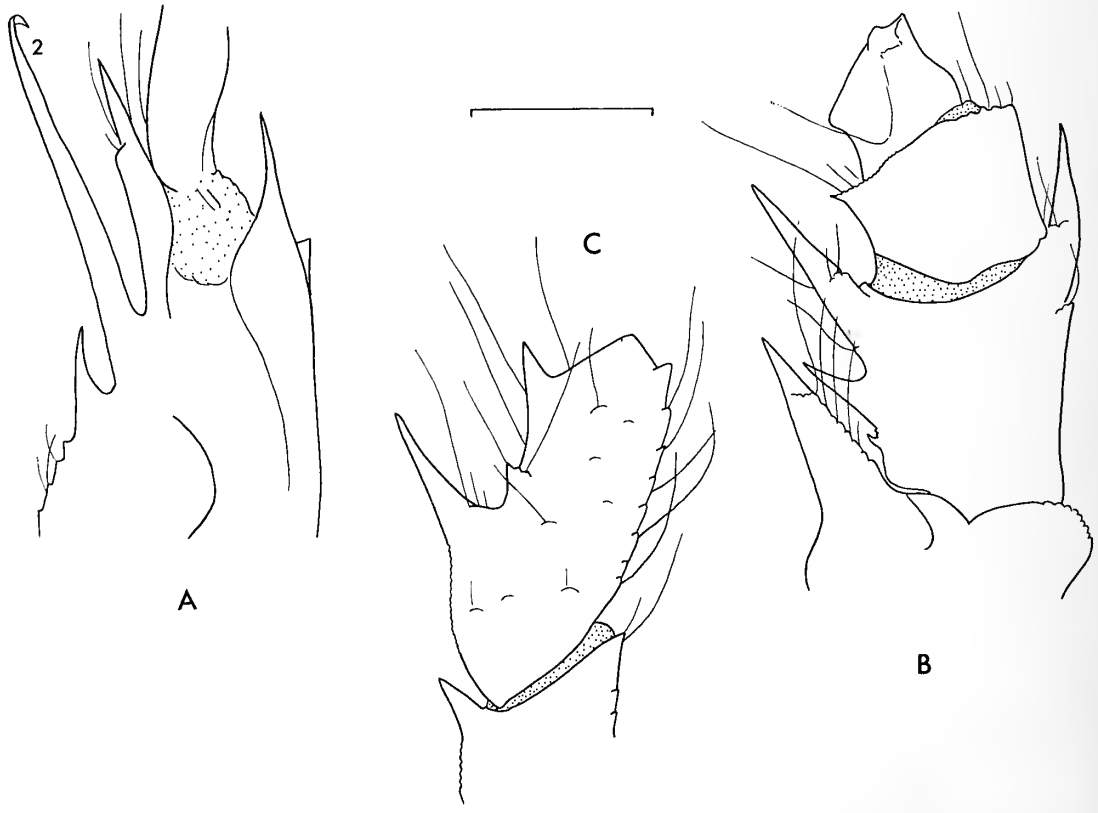


FIG. 19. *Munida andamanica* Alcock. A. Distal part of basal segment of right antennule, dorsal view. B. Left antennal peduncle. C. Merus of left third maxilliped. (Scale = 1 mm.)

The chelipeds are less than twice the length of the carapace except in a male from St. 109 where they are a little more than three times the length of carapace (Alcock also had one male where the chelipeds were exceptionally long—1901, p. 243). The chelipeds are beset with long plumose setae which may give a feathery look to the appendage (Fig. 17*A*), but usually the hairs are so clamped to the surface that it is not easy to determine their nature. The second, third and fourth legs agree with the description given by Alcock, the long hairs mentioned by him are also plumose like those of the chelipeds. The dactylus of the fourth leg is illustrated in Fig. 17*B*.

The first and second pair of pleopods of the males are very similar to those of *M. microps* (see Figs. 14*D*, *E*), except that the anterior curled margin of the first pleopod is more heavily setose and the apical angle is produced into a spout which is strikingly similar to that of *M. elegantissima* (Fig. 12*E*).

The youngest male from St. 188 differs from all the others in having a very long and strongly serrated rostrum (incomplete) as shown in Fig. 17*C* and which measures 4 mm. in length (c.l. = 7 mm.). After I had made the drawing it came off and the line of break is indicated by a double dotted line. In nearly all the others the rostrum is a little more than half the length of carapace, strongly uptilted and finely serrated near the apex.

Munida vigiliarum Alcock

(Fig. 20)

Munida vigiliarum Alcock, 1901, p. 243.
Munida vigiliarum, Doflein and Balss, 1913, p. 147, pl. XIII, fig. 2.

Occurrence : *Zanzibar area :* St. 107, Agassiz trawl, 421–457 metres, 1 male (c.l. + r. = 15 mm., ch.l. = 41 mm.).

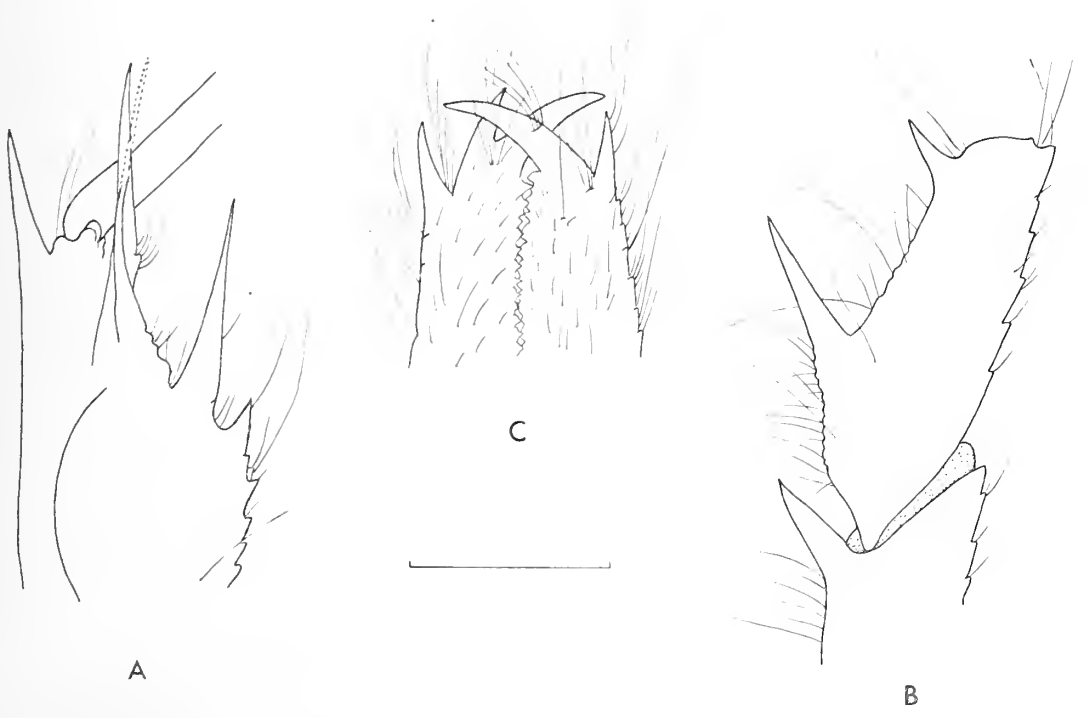


Fig. 20. *Munida vigiliarum* Alcock. A. Basal segment of right antennule, dorsal view. B. Middle part of left third maxilliped. C. Tip of left chela. (Scale = 1 mm.)

DISTRIBUTION : Indian Ocean.

DESCRIPTIVE REMARKS : This species was described by Alcock in 1901 and was for the first time figured by Doflein and Balss (1913, pl. XIII, fig. 2). The " John Murray " material consists of a single male which differs from the earlier specimens as described below :

Alcock (1901, p. 244) writes that the " Antero-lateral border of carapace [is] with 7 spines. " Doflein and Balss figure eight spines (3 + 3 + 2) on the lateral border of the carapace. In the " John Murray " specimen there is another small spine behind the third spine, placed immediately anterior to the first cervical branch (4 + 3 + 2). The transverse gastric row consists of ten spines. The two sub-median spines are small and each has laterally two large and one small spine, these eight spines make a more or less straight row. The last pair of spines stands further back and more laterally. The two median spines shown by Doflein and Balss are not present in the " John Murray " specimen, nor were they mentioned by Alcock. In addition to the spines behind the bifurcation of the cervical groove there is also a small spine in the right cervical triangle. The supra-orbital spines do not reach as far as the distal margin of the cornea. The abdomen, as pointed out by Alcock, is armed with a row of spines on the anterior margin of the second tergum and a pair on the same margin of the following tergum.

The ocular peduncle has few tufts of hairs and the cornea is fringed with short " lashes ".

The basal segment of the antennule has five spines, four of which are long and sharp as represented in Fig. 20*A*. The basal segment of the antenna has its disto-median angle produced into a spine; the following segment has two spines, of which the inner is the longest of the antennal spines.

The ischium of the third maxilliped has a spine on its disto-median angle. The merus has a large proximal and a small distal spine on its inner border (Fig. 20*B*). Alcock mentions only one spine on this segment.

The chelipeds are long and sub-equal, they are hairy as well as thorny. Four longitudinal rows of spines extend from the merus to the palm, the outer and the inner of these rows are also continued on to the fingers. The tip of the chela is represented in Fig. 20*C*. The spinosity of the walking legs has been described by Alcock and is as figured by Doflein and Balss, except that they have shown the dactyli to be annulated. In the "John Murray " specimen they are very similar to those of *M. andamanica* (Fig. 17*B*), except that the row of plumose hairs, near the base of the segment, is placed more medially.

The first and second pair of pleopods show a striking resemblance to those of *M. andamanica*.

Munida tricarinata Alcock

(Fig. 21)

Munida tricarinata Alcock, 1894, p. 324.
Munida tricarinata, Alcock, 1901, p. 246 ; Ill. Zool. Investigator, Crust., pl. XII, fig. 1 ; Laurie, 1926, p. 138.

OCCURRENCE : *Zanzibar area :* St. 106, Agassiz trawl, 183–194 metres, 1 male in poor condition (c.l. + r. = 10 mm.).

Maldive area : St. 149, triangular dredge, 238 metres, 1 male (c.l. + r. = 14 mm., ch.l. = 55 mm.) ; 3 ovig. females (c.l. + r. = 12–14 mm., ch.l. = 44–47 mm.).

St. 153, triangular dredge 4, 256–293 metres, 2 females, larger ovig. (c.l. + r. = 13 mm., 16 mm., ch.l. missing—50 mm.).

St. 154, Agassiz trawl, 457 metres, 1 male (c.l. + r. = 7 mm.).

DISTRIBUTION : Indian Ocean.

DESCRIPTION : Since Alcock's description of the species was rather brief, the following description and illustrations are based on the " John Murray " male taken at St. 149 :

The carapace is nearly as long as it is broad (not including the rostrum). The lateral margins, which are slightly convergent anteriorly as well as posteriorly, are armed with a large antero-lateral spine and about eight smaller spines following it. The entire surface of the carapace is covered with small tubercles, from the centre of each of which arises an anteriorly directed spinule, flanked by hairs of about the same length. Scattered among these are a few spineless tubercles which, nevertheless, have a fringe of hairs. The rostrum is short and acutely triangular with a broad depressed base and an upturned tip which does not reach beyond the cornea. The rostral carina is continued

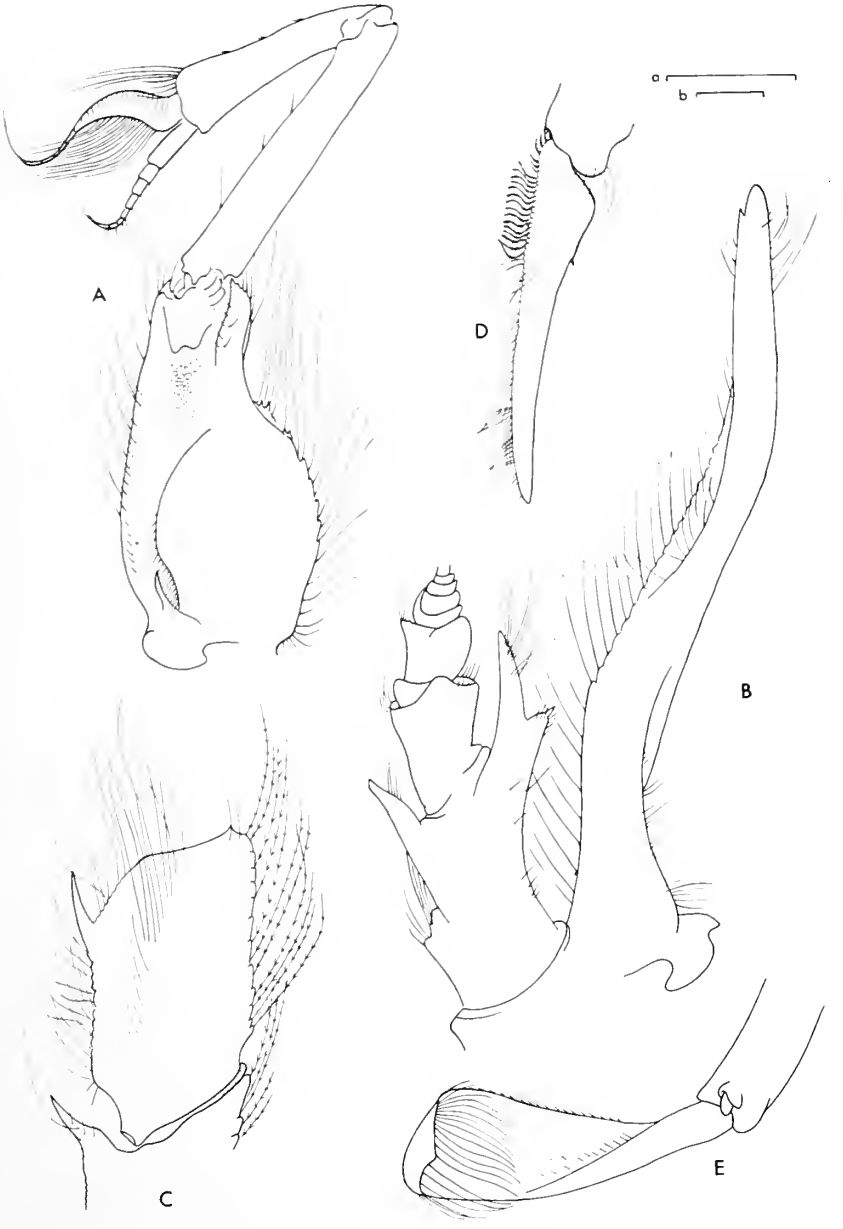


FIG. 21. *Munida tricarinata* Alcock, male. A. Dorsal view of right antennule (scale *a* = 1 mm.). B. Dorsal view of right antenna (scale *a*). C. Merus of left third maxilliped (scale *a*). D. Dactylus of first ambulatory leg (scale *b* = 1 mm.). E. Distal part of left second pleopod, ventral view.

over the gastric region which has on the anterior half two to three minute spines followed by three bigger spines. As a continuation of this median series, the cardiac region has three to four still larger spines. The posterior margin of the carapace is furnished with small spines, of which the median is largest and most conspicuous. Thus a median row of prominent spines extends from the gastric region to the posterior margin of the carapace. There are two more longitudinal rows of slightly smaller spines, one on either side of the median row ; the anterior and the largest spine of each of these lateral rows is placed behind and only slightly lateral to the supra-ocular spines. The supra-ocular spines are just over half the length of rostrum (Alcock, pl. XII, fig. 1).

The second to fourth abdominal terga are grooved transversely, both margins of the groove being carinate. The anterior carinae of all three segments have each four spines, two of which are sub-median in position and the other two are placed near the lateral margins. A few small spines are present on either side and posterior to the lateral spines. The posterior carina of the second and the third tergum has a pair of sub-median spines in the same position as the anterior one, but the fourth has only a single median spine as already pointed out by Laurie (1926, p. 139). A few small spines are present on the second pleura while the next two have hairy ridges. The elaborate sculpture of the last two somites is represented by Alcock (1901, pl. XII, fig. 1). The telson of the males, except in the youngest, has a few spines in the centre of the dorsal surface.

The eyes are remarkably flat. The cornea is narrow and crescent-like. The ocular peduncles widen out distally and have three half rings of hairs.

The basal segment of the antennule becomes narrow distally giving a characteristic shape to the segment (Fig. 21*A*). Moreover, there are no spines present on this segment. The disto-median angle of the basal segment of the antenna is produced into a spine of enormous size (Fig. 21*B*), which affords an important feature in the recognition of the species. The second segment has distally a small spine on the outer, and a much larger bifurcated one on the inner, border.

The inner distal margin of the ischium of the third maxilliped has a spine, and another spine is present on the inner border of the merus (Fig. 21*C*).

The entire surface of the long and sub-equal chelipeds is covered with hairy scales which are more conspicuous on the palm of the chela and rather obscure on the ischium. Furthermore, the ischium has just a pair of posteriorly directed spines on the proximal border, one on each margin. These spines abut against the much larger, anteriorly directed processes of the preceding segment. The merus has a dorsal, an inner, and a ventral, longitudinal row of spines which are continued on the carpus where they are smaller in size. Only the inner margin of the palm has a few spinules. The fingers of the chela are nearly as long as the palm. The fixed finger bifurcates at the tip to hold the claw-like tip of the movable finger. The fixed finger also has a fringe of short hairs on the proximal half just above the serrated inner margin. The next three pairs of legs are long and remarkably flattened dorso-ventrally. Their surface is covered with setose scales. The ischium has a spine distally on its posterior margin. Both the anterior and posterior margins of the merus are spiny, the distal spine of the posterior row is much larger than the others. The anterior margin of the carpus and the posterior margin of the propodus is spiny, the inner distal angle of the carpus is also provided with a spine. The propodus and the dactylus are very thin and blade-like ; the dactylus is illustrated in Fig. 21*D*. The posterior border is smooth except for one or two small spines on the dactylus of the first pair. The anterior border bears a row of plumose setae proximally and simple hairs distally, as illustrated.

In the males of *M. tricarinata* the first pair of pleopods are wanting. The endopod of the second pleopod is represented in Fig. 21*E*. The distal margin of the endopod is curled ventrally and fringed with long hairs. In the youngest male (c.l. + r. = 7 mm.) the endopod is hardly differentiated from the stalk, but in the male measuring about 10 mm. in carapace length the characteristic adult form has been attained.

Munida incerta Henderson

(Fig. 22)

Munida incerta Henderson, 1888, p. 130, pl. XIII, fig. 4.
Munida incerta, Barnard, 1926, p. 122 ; 1950, p. 492, fig. 92 ; Yanagita, 1943, p. 15, 1 and 2.

Occurrence : *Zanzibar area :* St. 107, Agassiz trawl, 421–457 metres, 7 males (c.l. + r. = 12·5–34 mm., ch.l. = 32·5–92 mm.).

St. 115, otter trawl, 640–658 metres, 1 female (c.l. + r. = 20 mm. tip of rostrum broken—no cheliped).

Distribution : Philippine Islands; Delagoa Bay, Portuguese East Africa; Japan.

Descriptive remarks : This species is very closely related to *M. tricarinata* but the two species can easily be distinguished from each other. The rostrum and supra-orbital spines are arched in *M. incerta* and a spine of considerable size is present behind each supra-orbital spine. Moreover, on either side of the cardiac area is a row of three spines arranged longitudinally. The lateral margin of carapace is armed with six spines. The entire surface of the carapace is covered with hairy striae. The anterior margin of each of the second to fourth abdominal terga has four widely separated spines. A median spine is present on the posterior margin of the fourth tergum only.

The antennule differs from that of *M. tricarinata* in having spines on the distal margin of the basal segment (Fig. 22*A*). The antennae of the two species are very similar ; in *M. tricarinata* the spine of the basal segment slightly exceeds twice the length of segments 2–4 whereas in *M. incerta* it is just one and a half times their combined length ; the inner spine of the following segment has the small subsidiary spine situated nearer its base and not so distal as in *M. tricarinata* (cf. Fig. 21*B*).

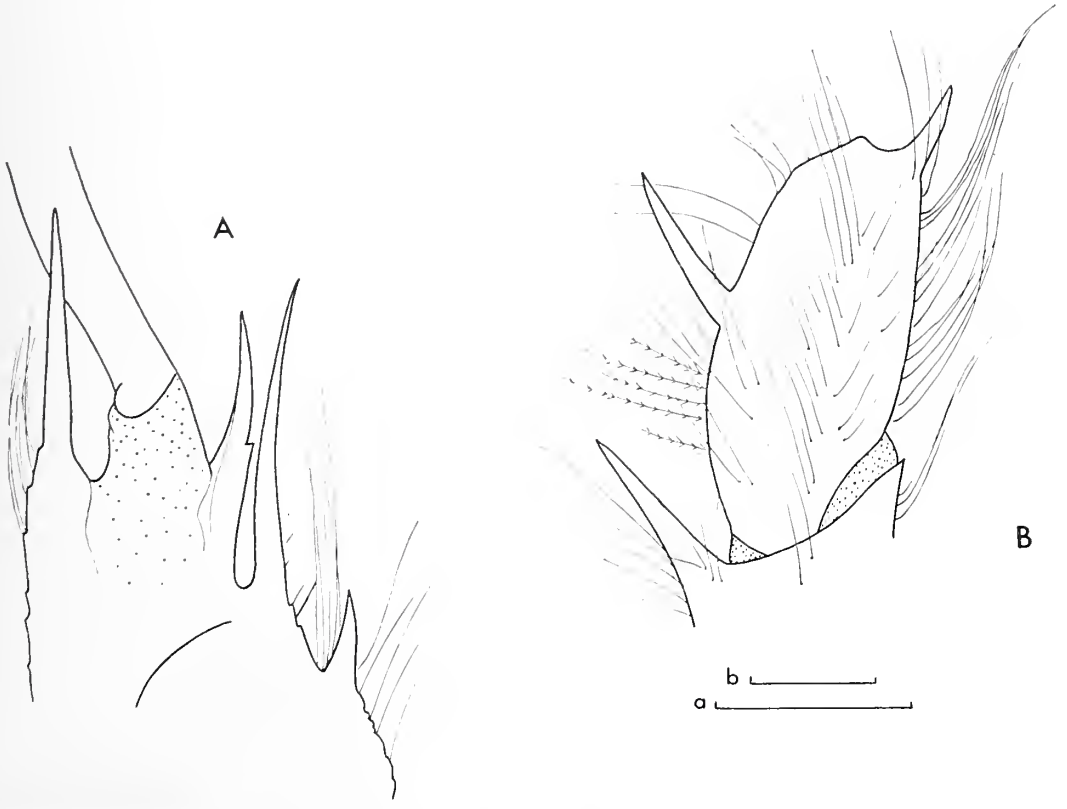


Fig. 22. *Munida incerta* Henderson. A. Distal part of basal segment of right antennule, dorsal view (scale *a* = 1 mm.). B. Merus of left third maxilliped (scale *b* = 1 mm.).

The ischium of the third maxilliped has its disto-median angle produced into a strong spine, an equally strong spine is present on the inner margin of the merus (Fig. 22*B*). The outer distal angle of the merus also has a spine which is smaller than the other two spines.

The chelipeds are either equal or somewhat unequal. The spinosity of the chelipeds and of the walking legs are similar to those of *M. tricarinata*. In the largest specimen, which is a male, the chelipeds are very stout and the setose scales on the surface are very prominent. In the smaller specimens they become progressively smaller so that in the smallest male they are scarcely apparent. Further, the chelipeds of the young specimens are slender, hardly stouter than the walking legs. The fingers of the chela, in the largest specimen, have two projections near the base which fit in the corresponding excavations of the opposed finger.

The first pair of pleopods is absent in the males. The second pair resembles those of *M. tricarinata*. In the juvenile male (c.l. + r. = 12·5 mm.) the second pleopod shows an early stage of development ; the endopod is represented by a finger-like lobe which is only about a third as long as the stalk and the apex is neither curled nor fringed with hairs.

Sub-family **MUNIDOPSINAE** Ortmann

Genus ***GALACANTHA*** A. Milne-Edwards

Doflein and Balss (1913, p. 174) tabulated the known geographical and bathymetric distribution of the following six species, comprising the genus *Galacantha : G. camelus* Ortmann, *G. diomedeae* Faxon, *G. rostrata* A. Milne-Edwards, *G. spinosa* A. Milne-Edwards, *G. trachynotus* Anderson, *G. valdiviae* Balss.

Boone (1927) added *G. barbarae* as a new species from the Atlantic. Chace (1942) on the basis of his extensive study of the Atlantic species merged this genus with *Munidopsis*. He considered *diomedeae*, *rostrata*, *spinosa*, *trachynotus* and *valdiviae* as representing the typical forms of the genus and *G. camelus* as an intermediate step between the two genera. Dr. Chace also regarded the various sub-genera of *Munidopsis* as unnatural groups. In this report, however, the genus *Galacantha* is regarded as a separate genus and the " John Murray " species of the genus *Munidopsis* are grouped according to the various sub-genera. Although they may not form natural groups this subdivision is rather convenient in handling the systematics of such a big genus.

Key to the determination of the Indian Ocean species of Genus *Galacantha* A. Milne-Edwards

I. Carapace covered with setose tubercles, posterior margin unarmed ; dactyli of walking legs not flattened dorso-ventrally . . . . . ***G. rostrata*** A. Milne-Edwards

II. Carapace covered with spiny tubercles, posterior border spiny ; dactyli of walking legs flattened dorso-ventrally. ***G. trachynotus*** Anderson

Glacantha rostrata A. Milne-Edwards

(Figs. 23, 24)

Galacantha rostrata A. Milne-Edwards, 1880, p. 52.

Galacantha rostrata, Smith, 1882, p. 21, pl. 9, figs. 2, 2a ; 1884, p. 355 ; Milne-Edwards and Bouvier, 1894, p. 271 ; 1897, p. 60, pl. 4, figs. 21–24 ; 1900, p. 308, pl. 6, fig. 9 ; Faxon, 1895, p. 78, pl. B, figs. 1, 1a ; Alcock, 1901, p. 275 ; Stebbing, 1908, p. 20 ; Hansen, 1908, p. 35 ; Barnard, 1950, p. 494, figs. 92, e–f.

Munidopsis rostrata Smith, 1885, p. 493 ; 1886, p. 45, pl. 6, figs. 1, 1a ; Chace, 1942, p. 75.

Galacantha talismani Filhol, 1885, pl. 3 ; Perrier, 1886, p. 341, text-fig. 242(8).

Galacantha talismani Henderson, 1888, p. 167, pl. xx, fig. 1.
Galacantha bellis Henderson, 1885, p. 413 ; 1888, p. 167, p. xix, fig. 6.
Galacantha areolata Wood-Mason and Alcock, 1891, p. 200 ; 1894, p. 173 ; Ill. Zool. Investigator, Crust., pl. LV, figs. 5, 5a (= *G. rostrata*).
Galacantha investigatoris Alcock & Anderson, 1894, p. 173 ; Ill. Zool. Investigator, Crust., pl. XII, fig. 4.
Galacantha rostrata var *investigatoris* Alcock, 1901, p. 276.
Galacantha faxoni Benedict, 1902, p. 304.

Occurrence : *Gulf of Aden :* St. 26, Agassiz trawl, 2312 metres, 1 ovig. female (c.l. + r. = 22 mm., ch.l. = 24 mm.).

St. 185, Agassiz trawl, 2000 metres, 1 female (c.l. + r. = 28 mm., ch.l. = 30 mm.).

Northern area of Arabian Sea : St. 62, Agassiz trawl, 1893 metres, 1 ovig. female (c.l. + r. = 8 mm., ch.l. = 10 mm.).

Zanzibar area : St. 118, Agassiz trawl, 1789 metres, 1 male (c.l. + r. = 21 mm., ch.l. = 29 mm.).

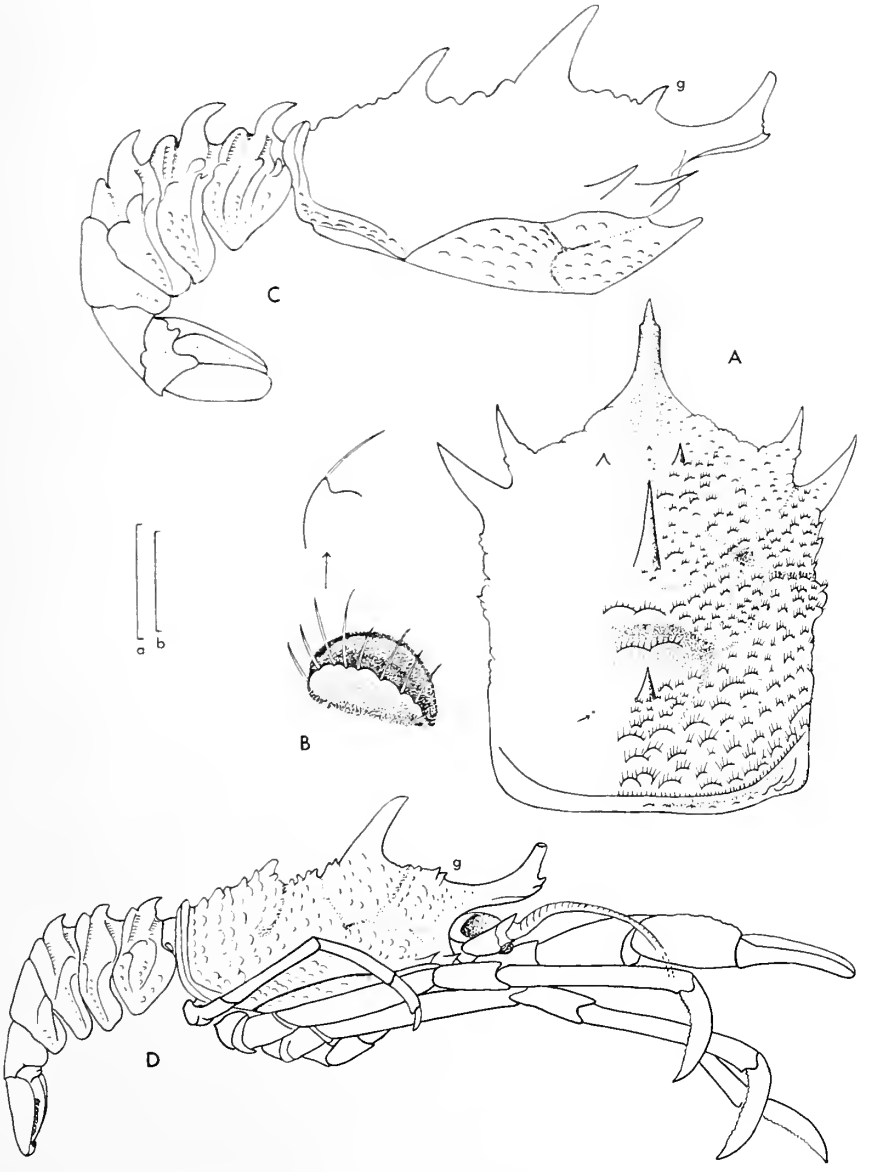


Fig. 23. *Galacantha rostrata* A. Milne-Edwards. A. Carapace of female, dorsal view (scale *a* = 6 mm.). B. One scale from carapace (its position indicated by an arrow in A) highly magnified with, above, diagrammatic profile of same. C. Lateral view of female, scales omitted from carapace (scale *b* = 6 mm.) ; *g*, gastric spine. D. Lateral view of male (scale *b*) ; *g*, gastric spines.

DISTRIBUTION : Atlantic, Indo-Pacific.

DESCRIPTIVE REMARKS : The carapace of the largest female is represented in Figs. 23*A* and *C*. The distal portion of the rostrum is directed almost vertically upwards and the lateral teeth at its base are only very slightly developed. The entire surface of the carapace is covered with tubercles. These tubercles, however, vary in size and structure on the different areas of the carapace. A small anterior area has simple tubercles, while the greater part of the carapace is covered with scaliform tubercles. A close study of the tubercles shows that each has an anteriorly raised and scalloped margin from the recesses of which anteriorly directed setae emerge (Fig. 23*B*, lower sketch) ; the upper one is a diagrammatic representation of a single tubercle in profile. On the postero-lateral area of the carapace these tubercles are situated close to one another and even run as short ridges. Some of these may become tipped with spinules.

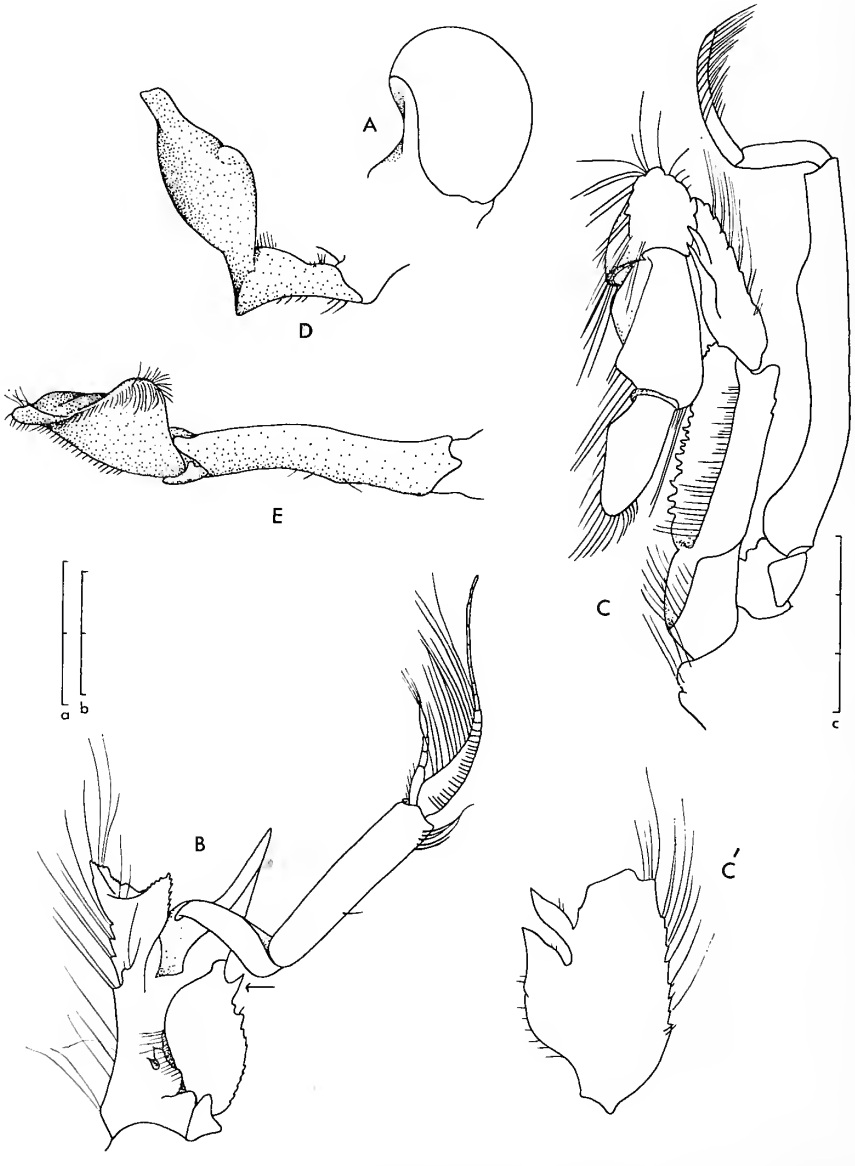


FIG. 24. *Galacantha rostrata* A. Milne-Edwards. A. Right eye, lateral view (scale *a* = 2 mm.). B. Right antennule, dorsal view (scale *b* = 2 mm.). C. Left third maxilliped (scale *c* = 3 mm.). C′. Merus of third maxilliped (scale *a*). D. Left first pleopod of male, ventral view (scale *b*). E. Left second pleopod of male, ventral view (scale *b*).

The abdomen agrees with the description given by Alcock (1901, p. 276) and is illustrated in Fig. 23*C*.

The ocular peduncle is produced into a scale-like structure on the medial size of the cornea, giving it a reniform appearance (Fig. 24*A*).

The antennule is represented in Fig. 24*B*. The merus of the third maxilliped has two large spines on the inner margin (Figs. 24*C*, *C'*).

In the smallest female which measures 8 mm. in carapace length, including rostrum, the distal part of the rostrum slopes gently upwards and the tubercles on the carapace are simple rounded projections. A median spine is present on each of the second and third abdominal terga but the anterior margin of the fourth is produced into a small, blunt, median tooth-like projection.

The single male specimen belonging to this species differs from the females in having the paired gastric spines smaller (cf. *g* Fig. 23*C*, *D*). The carapace is more closely covered with tubercles which, moreover, have all the setae dark amber-coloured (colourless in the female). The median spines on the abdominal terga are smaller than in the female of about the same size (Fig. 23*D*). The first and second pleopods of the male are illustrated in Figs. 24*D*, *E*.

Remarks : On the basis of some differences Alcock (1901, p. 276) established *investigatoris* as a variety of *G. rostrata*. The " John Murray " specimens, however, belong to the typical form since the lateral rostral teeth are small and the abdomen has very few tubercles—as described by Alcock for *G. rostrata*.

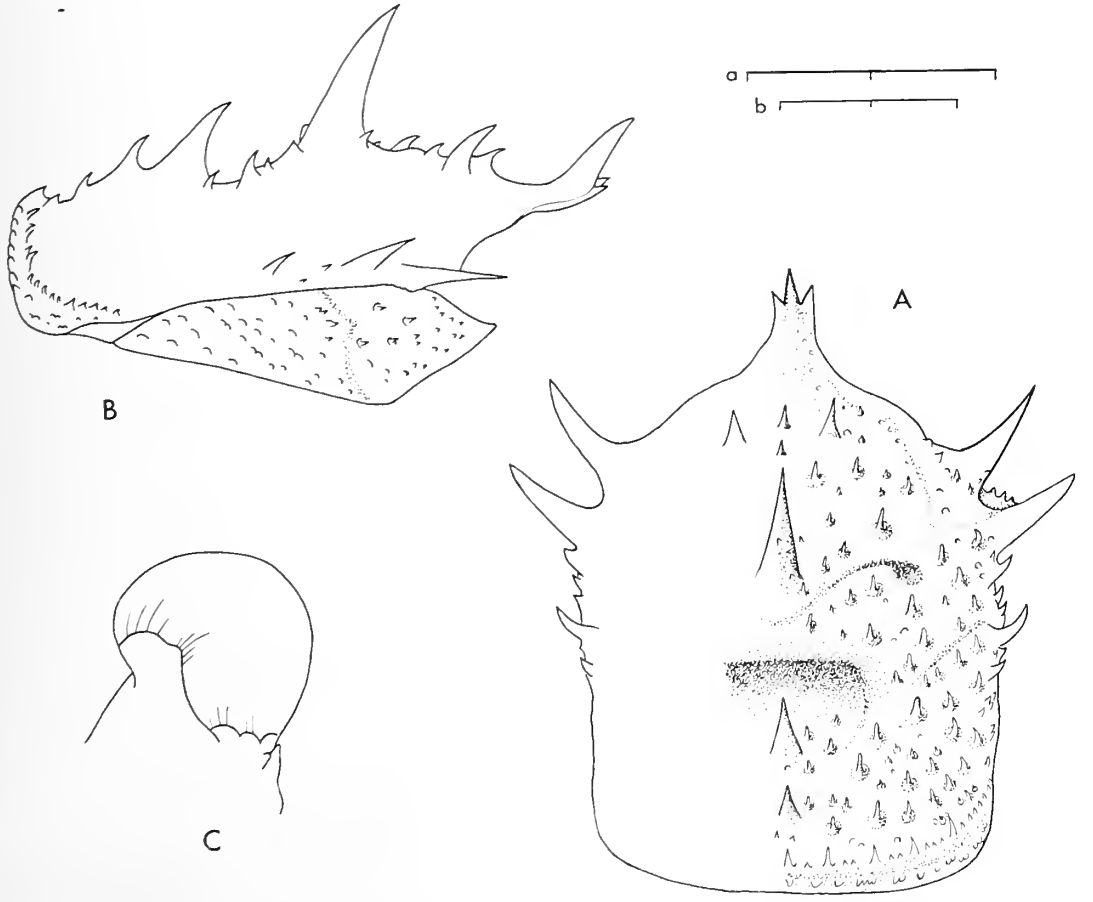


Fig. 25. *Galacantha trachynotus* Anderson, male. A. Carapace, dorsal view (scale *a* = 12 mm.). B. Lateral view of same carapace (scale *a*). C. Right eye, lateral view (scale *b* = 2 mm.).

Galacantha trachynotus Anderson

(Figs. 25, 26)

Galacantha trachynotus Anderson, 1896, p. 100.
Galacantha spinosa A. M.-Edw. var. *trachynotus* Alcock, 1901, p. 277 ; Ill. Zool. Investigator, Crust., pl. XXV, fig. 3.

Occurrence : *Northern area of Arabian Sea :* St. 62, Agassiz net, 1893 metres, 2 males (c.l. + r. = 28 and 32 mm., ch.l. = 35 and 45 mm. respectively) ; 2 females (c.l. + r. = 26 and 30 mm., ch.l. = 30 and 36 mm. respectively).

Distribution : Indian Ocean.

Remarks on material : The larger female is ovigerous and the larger male is infested with a large Rhizocephalan emerging between abdominal somites 4 and 5.

Descriptive remarks : Although all four " John Murray " specimens are much larger than the largest specimen recorded by Alcock (1901, p. 277), they agree very well with his description. The carapace of a male, measuring 28 mm. in length, is illustrated in Figs. 24*A*, *B*. The fifth and sixth abdominal terga differ from Alcock's description in bearing spines instead of " . . . some scattered tubercles " (p. 277). The fifth abdominal tergum has a row of spines on its anterior margin which extends over the corresponding pleura, posterior to this there are about four in-

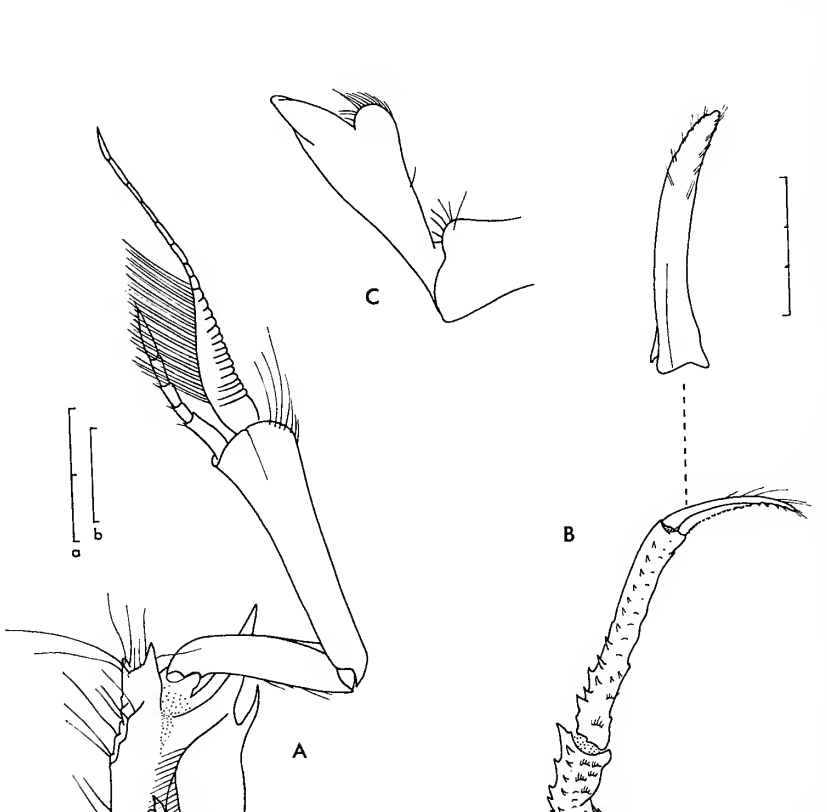


Fig. 26. *Galacantha trachynotus* Anderson. A. Right antennule, dorsal view (scale *a* = 2 mm.). B. Right second leg, lateral view (scale *b* = 6 mm.) and dactylus of same leg from above (scale *c* = 3 mm.). C. Endopod of left first pleopod of male, ventral view (scale *a*).

definitely arranged rows of small spines, some of which extend over the pleuron. The sixth tergum and the pleura have smaller spines scattered over their surface and still smaller ones are present on the telson.

The eye of *G. trachynotus* differs from that of *G. rostrata* in having a more rounded cornea and the distal border of the stalk setose and sinuous (Fig. 25 *C*—cf. Fig. 24*A*). The antennule is represented in Fig. 26*A*.

The dactyli of 2nd to 4th legs are very characteristic. Each dactylus is bent and flattened dorso-ventrally (antero-posteriorly). A row of spinules runs mid-ventrally and the tip is hairy as represented in Fig. 26*B*.

The first and second pairs of pleopods resemble those of *G. rostrata*, except that the first one is not so curled and the lobe present on its anterior margin can easily be observed (Fig. 26*C*).

Genus ***MUNIDOPSIS*** Whiteaves

Dr. Chace (1942, p. 69) estimated 115 species in the genus *Munidopsis ;* Doflein and Balss (1913, p. 177) had tabulated the known geographical and bathymetric distribution of 106 of these species. The only additions known to me are *M. okadai*, a new species from Japan, described by Yanagita (1942, p. 93), and *M. sundi* described by Sivertsen and Holthuis (1956, p. 44) from near the Azores, North Atlantic.

Key to the determination of the Indian Ocean sub-genera of the Genus *Munidopsis*

I. Propodus of each walking leg armed and expanded distally, to form a subchela with the flexed dactylus.
Bathyankyristes Alcock and Anderson

II. Propodus of walking legs normal, nor expanded distally to form a subchela with the flexed dactyli.
- A. Antero-lateral angles of the carapace rounded, lateral borders subcristiform ***Elasmonotus*** A. Milne-Edwards
- B. Antero-lateral angles of carapace spiniform, lateral borders not subcristiform.
  - a. Chelipeds shorter than the walking legs ; eye-stalks prolonged beyond the eyes as spines.
Orophorynchus A. Milne-Edwards
  - b. Chelipeds longer than the walking legs ; eye-stalks not prolonged beyond the eyes.
    1. Rostrum triangular, usually unarmed laterally (occasionally with serrations or spinules).
Munidopsis Whiteaves
    2. Proximal half of rostrum broad and ending anteriorly in a pair of distinct lateral spines ; distal part acute and styliform . . . . . ***Galathodes*** A. Milne-Edwards

Sub-genus ***BATHYANKYRISTES***

Munidopsis (Bathyankyristes) tenax Alcock

(Fig. 27)

Bathyankyristes spinosus Alcock, 1894, 174, pl. ix, fig. 2.
Munidopsis (*Bathyankyristes*) *tenax* Alcock, 1901, p. 273 ; Ill. Zool. Investigator, Crust., pl. LV, fig. 2.

Occurrence : *Zanzibar area :* St. 109, Agassiz trawl, 640 metres, 1 male (c.l. + r. = 23 mm., ch.l. = 36 mm.).
Maldive area : St. 143, Agassiz trawl, 797 metres, 1 female (c.l. + r. = 12 mm., ch.l. = 18 mm.).

Distribution : Indian Ocean.

DESCRIPTIVE REMARKS : The rostrum in the male is a little more than half the length of the carapace, its lateral margins are serrated and hairy. Each of these hairs has at least its distal half plumose, as also have the hairs on the surface of the carapace. The eye is illustrated in Fig. 27*A*. The basal segment of the antennule has two strong spines on its outer distal margin (Fig. 27*B*). The distal angles of the basal segment of the antenna are produced into short, triangular processes ; the same angles of the following segment each have a large spine ; the penultimate segment has a smaller spine on its inner distal angle and another of about the same size mid-ventrally, at the distal margin; the outer distal angle of the ultimate segment is produced into a somewhat rounded process.

The outer margin of the merus of the third maxilliped is serrated and terminates in a distal spine ; the inner margin is furnished with a strong median spine (Fig. 27*C*).

The chelipeds and ambulatory legs are hairy and spiny as described by Alcock (1901, p. 273). Each hair is plumose throughout its entire length.

The endopod of the first pleopod of the male is illustrated in Fig. 27*D* ; the anterior and posterior margins are curled dorsally near the apex to form a sort of spout ; the setose lobe on the anterior margin is slightly acuminate.

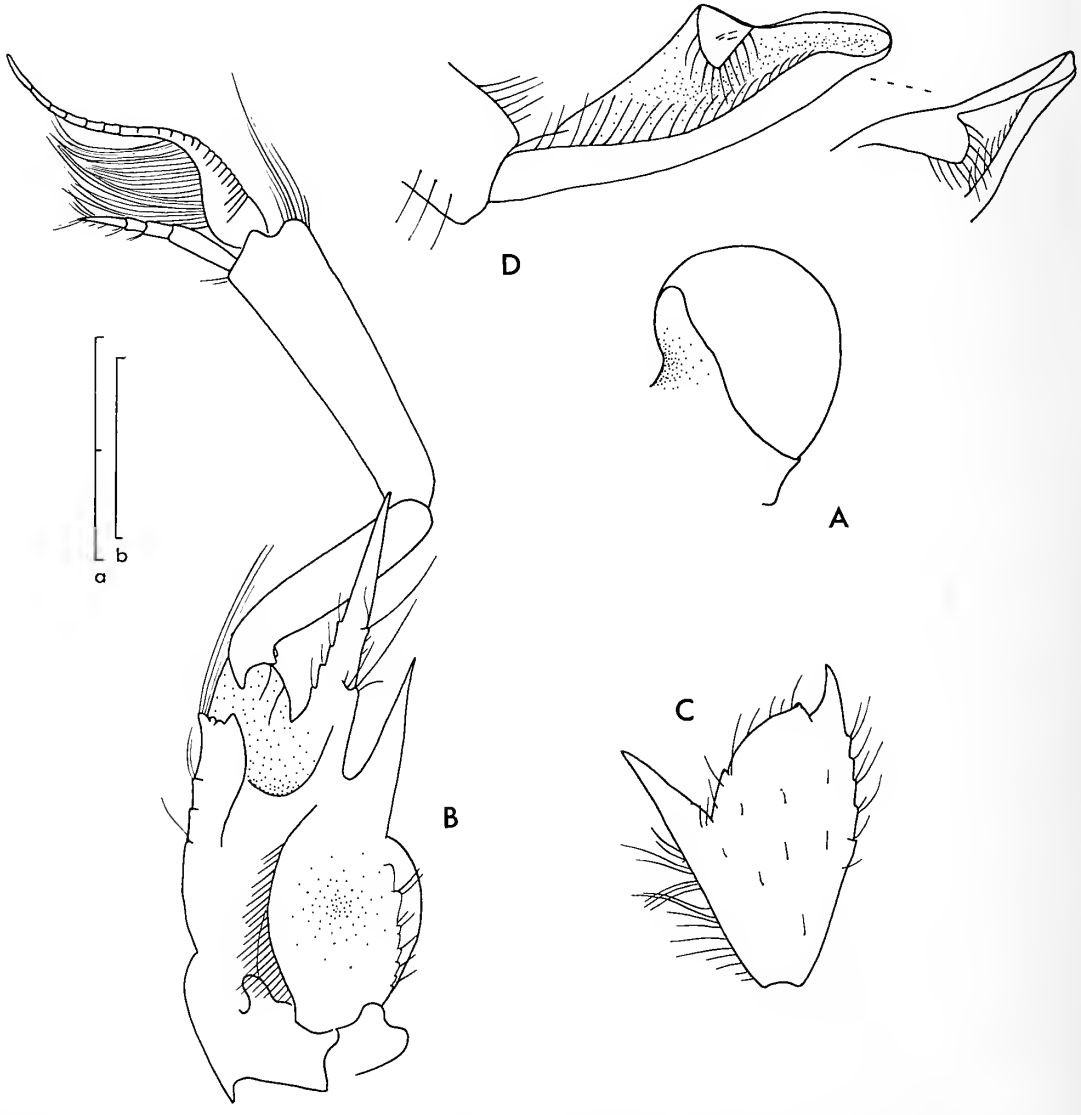


FIG. 27. *Munidopsis* (*Bathyankyristes*) *tenax* Alcock. A. Right eye, lateral view (scale *a* = 2 mm.). B. Right antennule, dorsal view (scale *a*). C. Merus of left third maxilliped (scale *a*). D. Endopod of left first pleopod of male, dorsal view and apex of same from a different angle (scale *b* = 1 mm.).

The young female taken at St. 143 differs from the male in that the carapace is less rugose and the hairs are sparse. The rostrum is almost half the length of the carapace. The chelipeds and the ambulatory legs are less hairy and with reduced armature. In all these characters the specimen approaches *M.* (*Bathyankyristes*) *levis* Alcock and Anderson (1894 and 1901). But in the " John Murray " specimen the eye-stalks are visible from above, as they are in the male ; this has been regarded as one of the distinguishing features between the two species (see Alcock, 1901, p. 251 and 274). In the illustration, however, the artist has shown a small portion of the eye-stalk in dorsal view of *Munidopsis* (*Bathyankyristes*) *levis* (1901, pl. LV, fig. 3).

Sub-genus *ELASMONOTUS*

Key to the determination of the Indian Ocean species of the sub-genus *Elasmonotus*

I. Rostrum triangular but not sharply pointed at the apex ; cornea long and cylindrical ; cheliped slender, more than twice the length of carapace . . . . . ***M. (Elasmonotus) cylindrophthalmus*** Alcock

II. Rostrum triangular and sharply pointed at the apex ; cornea small and globular ; cheliped stout and less than one and a half times the length of carapace . . . . . ***M. (Elasmonotus) debilis*** Henderson

Munidopsis (Elasmonotus) cylindrophthalmus Alcock

(Figs. 28, 29*A*, *B*)

Elasmonotus cylindrophthalmus Alcock, 1894, p. 333.
Munidopsis (*Elasmonotus*) *cylindrophthalmus* Alcock, 1901, p. 272 ; Ill. Zool. Investigator, Crust., pl. XIII, fig. 4.
Munidopsis (*Elasmonotus*) *cylindrophthalma*, Doflein and Balss, 1913, p. 159.

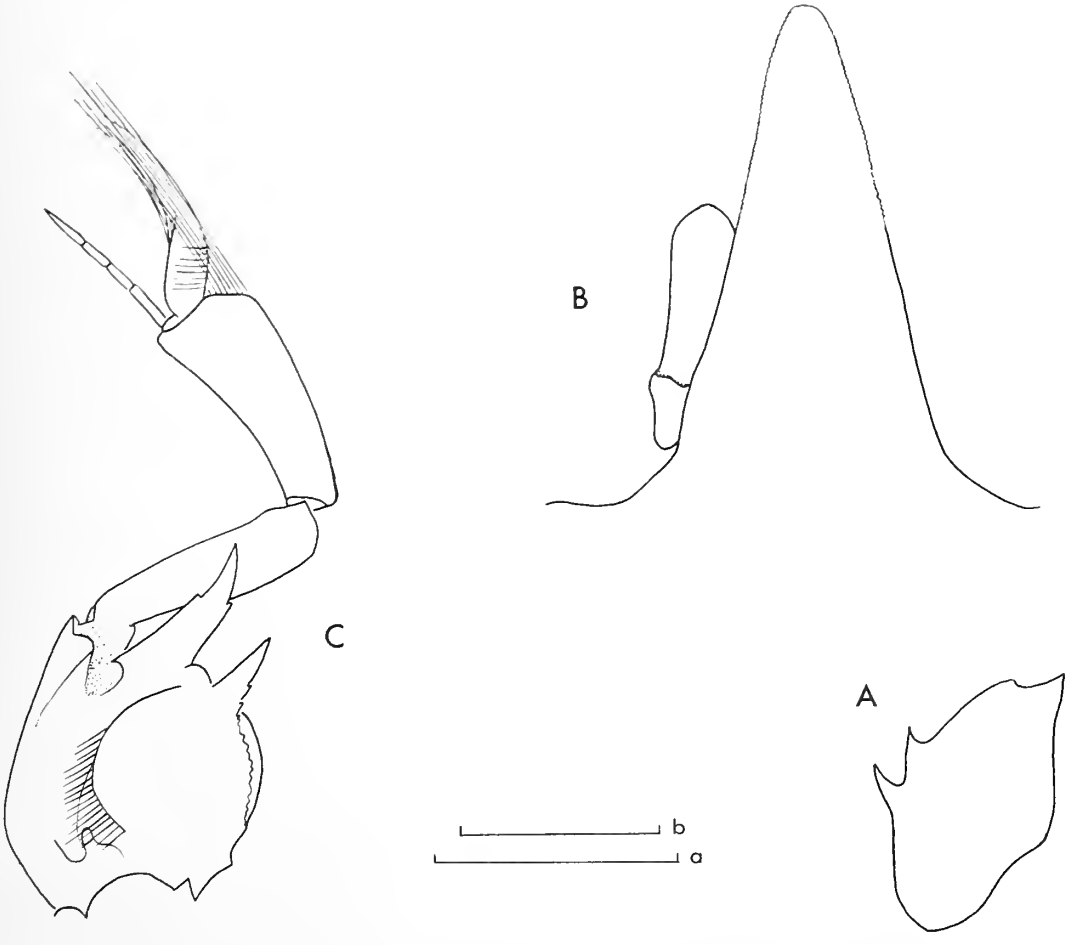


Fig. 28. *Munidopsis* (*Elasmonotus*) *cylindrophthalmus* Alcock. A. Rostrum and left eye (scale *b* = 1 mm.). B. Right antennule, dorsal view (scale *a* = 1 mm.). C. Merus of left third maxilliped (scale *a*).

OCCURRENCE : *Maldive area :* St. 145, Agassiz trawl, 494 metres, 1 female (c.l. + r. = 9·5 mm., ch.l. = 21 mm.).

DISTRIBUTION : Indian Ocean.

DESCRIPTIVE REMARKS : The single specimen in the " John Murray " collection is illustrated in Fig. 29*A*, *B*. It seems referable to Alcock's species although it differs from Alcock's description in the following respects : (1) There are two small spines on the inner margin of the merus of the

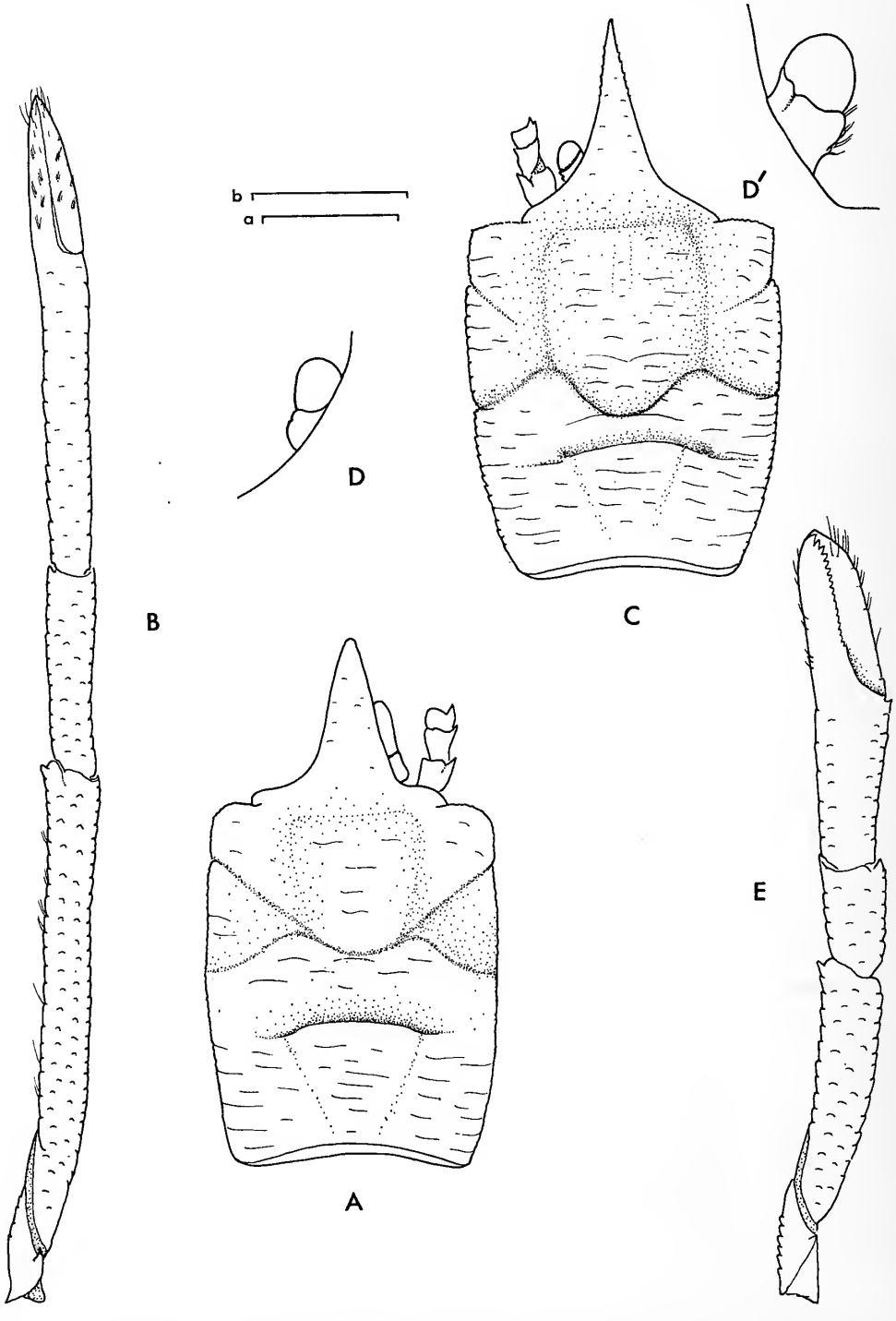


FIG. 29. *Munidopsis* (*Elasmonotus*) *cylindrophthalmus* Alcock. A. Dorsal view of carapace (scale *a* = 2·5 mm.). B. Cheliped (scale *a*). *Munidopsis* (*Elasmonotus*) *debilis* Henderson. C. Dorsal view of carapace (scale *a*). D. Left eye in normal position (scale *b* = 1 mm.) D′. Right eye, pulled out (scale *b*). E. Right cheliped (scale *a*).

third maxilliped (Fig. 28*A*) instead of " two small tubercles " (Alcock, 1901, p. 272). (2) The thoracic legs are not " perfectly smooth " as stated by Alcock ; the chelipeds are covered with squamiform scales and there is a small spine on the inner distal angle of the ischium (Fig. 29*B*). There are similar scales at least on the merus of the walking legs.

The rostrum and the eyes are shown at a higher magnification in Fig. 28*B* and the antennule is represented in Fig. 28*C*.

Munidopsis (Elasmonotus) debilis Henderson

(Figs. 29 *C–E*, 30)

Galathopsis debilis Henderson, 1885, p. 417.
Elasmonotus debilis Henderson, 1888, p. 165, pl. XVIII, fig. 4, 4a (specimen from Philippines only).

Occurrence : *Gulf of Aden :* St. 184, Agassiz trawl, 1270 metres, 1 male (c.l. + r. = 10 mm., ch.l. = 13 mm.).

Distribution : Philippine Islands.

Descriptive notes : The carapace of the " John Murray " specimen is represented in Fig. 29*C*. The rostrum is sharply pointed and upcurved, the lateral margins are finely serrated. The antero-lateral angles of the carapace are rounded as in *Munidopsis* (*Elasmonotus*) *cylindrophthalmus* but rather acuminate. The lateral margins of the carapace are serrated and diverge slightly anteriorly. The gastric area is well defined and rather convex, the entire surface of the carapace is rugose. The second to fourth abdominal terga have each a tranverse groove with carinated margins. The anterior carina of each transverse groove is better defined than the posterior one.

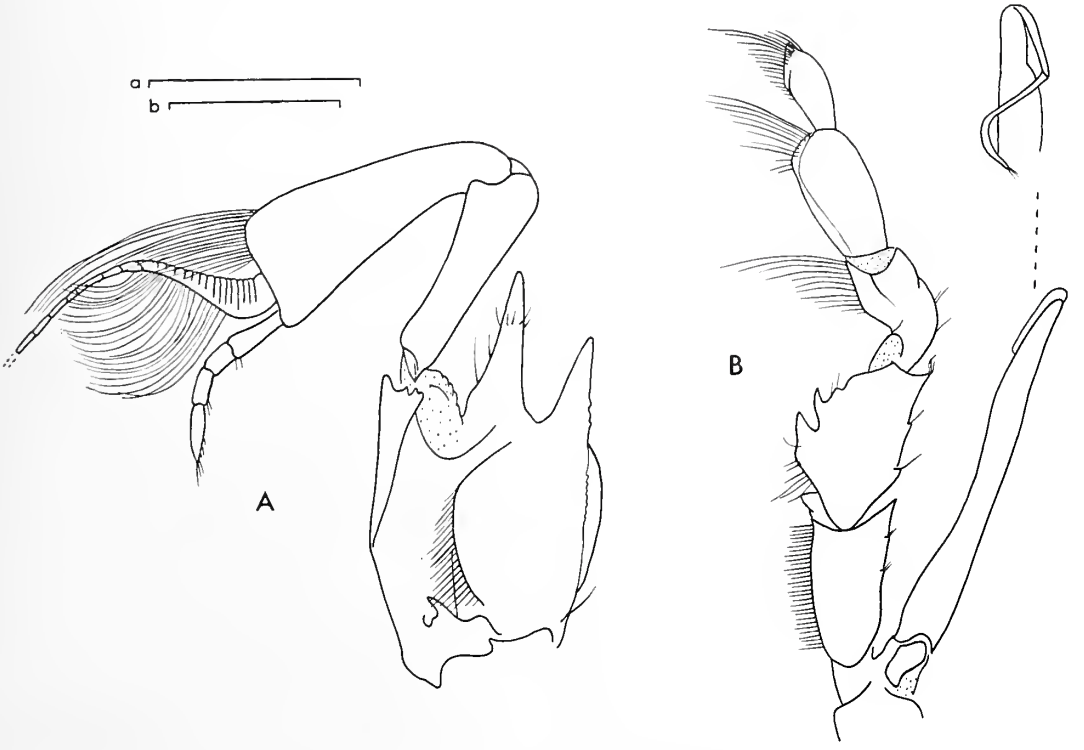


Fig. 30. *Munidopsis* (*Elasmonotus*) *debilis* Henderson. A. Right antennule, dorsal view (scale *a* = 1 mm.). B. Left third maxilliped (scale *b* = 1 mm.).

The eyes are remarkably small (Fig. 29*D*, *D'*). The antennule is illustrated in Fig. 30*A*. The inner and outer distal angles of the basal joint of the antennal peduncle are acute. The outer distal angle of each of the following three segments is produced into a spine ; the spine of the terminal segment is bifid.

The merus of the third maxilliped has two spines on its inner margin and a small spine on its outer distal angle (Fig. 30*B*).

The single remaining cheliped is short and stout (Fig. 29*E*). The scales covering the dorsal and lateral surfaces of the cheliped have sharp projecting anterior margins. On the ventral surface, which is rather smooth, the outer distal angle of the ischium and both distal angles of the merus are produced into small spines. The same angles of the carpus have small tooth-like projections.

The few ambulatory legs present are, like the cheliped, detached. They measure from eight to nine and a half millimetres in length. The ischium, merus and carpus of each leg is covered with hairy scales. The propodus is quite smooth and the dactylus terminates in a claw, behind which the posterior margin is strongly toothed.

The first and second pleopods are probably not fully developed. However, they are very similar to those of *M. scobina*.

Remarks : Henderson established this new species for two males, one from Matuku Island, Fiji and the other from the Philippine Islands. Both specimens are in the British Museum (Nat. Hist.) collection and, as stated by Henderson (1888, p. 165), are " in too fragmentary a condition to admit of a detailed description ". However, on careful examination these two specimens are seen to differ from one another. The larger one, that from the Philippines, should probably be selected as the lectotype because : (1) the left third maxilliped is missing from the specimen and that is the one represented in Henderson's fig. 4*a*, pl. XVIII, but the right one is still attached and agrees with the description and figure. (2) According to his footnote on p. 166 the artist must have made some mistake over fig. 4 since, according to the measurement given, the cheliped was just a trifle larger than the carapace (presumably including the rostrum). (3) The eyes are smaller than in the specimen from Fiji.

The chief reason for regarding the specimen from Fiji as different is because the eyes are much longer relative to the rostrum, and the cornea is elongated. In fact it seems to be more like *Munidopsis* (*Elasmonotus*) *cylindrophthalmus* Alcock. The detached fragment of one cheliped (ischium merus carpus) with this specimen is also much longer than one would expect in *debilis* according to Henderson's measurements. He gave no measurements for the smaller specimen.

Sub-genus *OROPHORYNCHUS*

Munidopsis (Orophorynchus) ciliata Wood-Mason

(Fig. 31)

Munidopsis ciliata Wood-Mason, 1891, p. 200.
Munidopsis ciliata, Faxon, 1895, p. 84.
Munidopsis brevimana Henderson, 1885, p. 414 ; Rep. Challenger Anomura, 1888, p. 154, pl. xvii, figs. 1 and 2.
Munidopsis (*Orophorhynchus*) *ciliata*, Alcock, 1901, p. 267 ; Illus. Zool. Investigator, Crust., pl. XI, fig. 3, 3a ; MacGilchrist, 1905, p. 248.

Occurrence : *Gulf of Aden :* St. 26, Agassiz trawl, 2312 metres, 1 male (c.l. + r. = 10·5 mm., ch.l. = 9 mm.).

Distribution : Indo-Pacific.

Descriptive notes : The single " John Murray " specimen referred to this species is a juvenile male. Henderson described the carapace as being covered with short transverse ridge-like elevations and " in some specimens also short hairs are sparingly met with ". Faxon (1895, p. 84) pointed out that the " Albatross " specimens were more hairy than those described by Henderson. In the " John Murray " specimen the hairs on the carapace are strikingly long. The lateral margins of the rostrum are finely serrated near the apex, some of the more posterior serrations become spinulous (Fig. 31*A*).

As illustrated in Fig 31*A*, the eye-stalk extends beyond the cornea as an outer and an inner spine, the inner spine is much longer and its base covers the cornea medially and also extends a little on to the ventral surface so that the cornea is not exposed median to this spine as is shown in Henderson's figure (1888, pl. xvii, fig. 1).

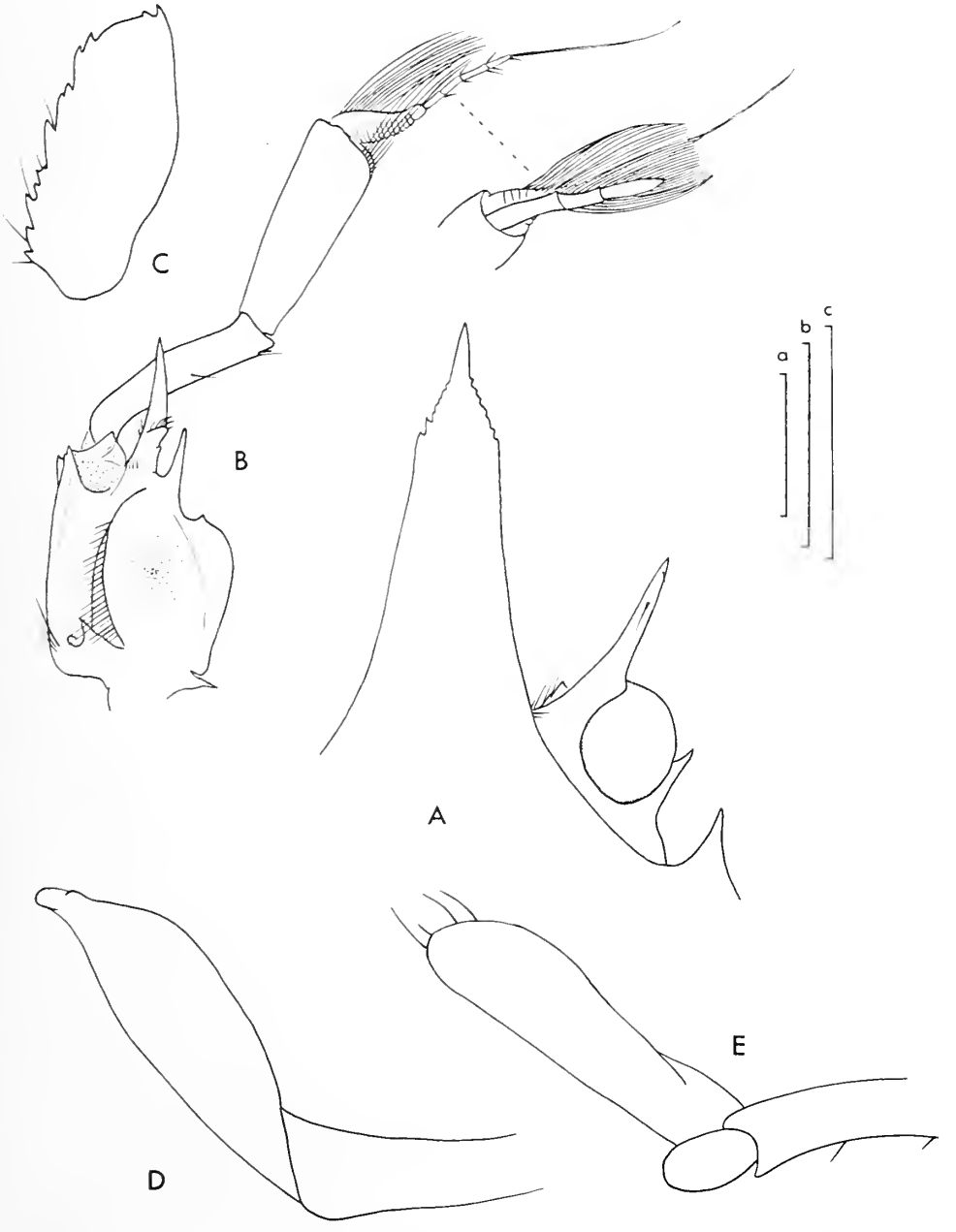


Fig. 31. *Munidopsis* (*Orophorhynchus*) *ciliata* Wood-Mason. A. Rostrum and right eye (scale *a* = 1 mm.). B. Right antennule, dorsal view (scale *b* = 1 mm.). C. Merus of left third maxilliped (scale *b*). D. Left first pleopod of male, ventral view (scale *c* = 0·5 mm.). E. Left second pleopod of male, ventral view (scale *c*).

The basal segment of the antennule has an inflated lateral margin (Fig. 31*B*), and the external spines are situated more distally than in most other species of this genus. The external flagellum terminates in a long lash which extends far beyond the other hairs which have a characteristic brush-like arrangement (Fig. 31*B*).

The basal segment of the antennal peduncle has its inner and outer distal angles produced into triangular processes. The second segment has a spine on its outer distal angle and only a spinule on the inner one, whereas the following segment has a spine on the inner distal angle and a spinule on the outer one. The outer distal margin of the ultimate segment is produced into a short blunt triangular process.

The merus of the third maxilliped has a serrated inner margin (Fig. 31*C*), but my representation of this segment is somewhat different from Henderson's figure of the same (pl. xvii, fig. 1a).

Alcock has already pointed out the presence of an epipodite on the cheliped (p. 267). It may be added here that this epipodite is as large as that of the third maxilliped.

The first and second pleopods illustrated in Fig. 31*D* and *E* show an early developmental stage.

Sub-genus *MUNIDOPSIS*

KEY TO THE DETERMINATION OF THE INDIAN OCEAN SPECIES OF SUB-GENUS *MUNIDOPSIS*

I. Epipodites present on chelipeds only . . . . . ***M. (Munidopsis) dasypus*** Alcock

II. No epipodites on chelipeds or legs.

A. Body and appendages with hirsute spines . . . . . ***M. (Munidopsis) spinihirsuta*** Lloyd

B. Body and appendages without hirsute spines.

I. Entire posterior border of carapace armed ; cornea ovoid . . ***M. (Munidopsis) scobina*** Alcock

II. Posterior border of carapace unarmed or with a few median spines ; eyes globular or cylindrical.

A. Posterior border of carapace unarmed ; abdominal terga also unarmed ; eyes globular. ***M. (Munidopsis) stylirostris*** Wood-Mason

B. Posterior border of carapace armed or unarmed ; second to fourth abdominal terga spinose ; eyes cylindrical.

a. Posterior border of carapace unarmed ; gastric and cardiac regions without a row of mid-dorsal spines. . . . . ***M. (Munidopsis) wardeni*** Anderson

b. Posterior border of carapace with median spines, gastric and cardiac areas with a row of mid-dorsal spines . . . . . ***M. (Munidopsis) wardeni mabahiss*** var. nov.

Munidopsis (Munidopsis) dasypus Alcock

(Fig. 32)

Munidopsis dasypus Alcock, 1894, p. 329.
Munidopsis dasypus, Alcock, 1901, p. 252 ; Ill. Zool. Investigator, Crust., pl. XIII, fig. 9 ; McGilchrist, 1905, p. 245.

OCCURRENCE : *South Arabian coast :* St. 50, triangular dredge 4, 1536–1939 metres, 1 male (c.l. + r. = 17 mm., ch.l. = 32 mm.).

Gulf of Aden : St. 184, Agassiz trawl, 1270 metres, 1 ovig. female (c.l. + r. = 24·5 mm., right ch.l. = 48 mm., left ch.l. = 38 mm.).

DISTRIBUTION : Indian Ocean.

DESCRIPTIVE REMARKS : In the two " John Murray " specimens, one male and one female, the rostrum has a mid-dorsal carina and the lateral margins are serrated. As pointed out by McGilchrist (1905, p. 245), the number of spines on the posterior margin of carapace are variable. All Alcock's specimens had four spines, McGilchrist's specimens had four to seven spines. In the " John

Murray" male there are five, while in the female the posterior margin of the carapace is armed with eight spines. Second to fourth abdominal terga each with a carinated anterior margin of which that on the fourth is very pronounced in the female.

The eye-stalk is elongate and has an oblique distal margin (Fig. 32*A*).

The basal segment of the antennule differs slightly in the two sexes. In the male (Fig. 32*B*) there is a single large spine on the outer side of the distal margin, at the base of which there is a minute spine. The female, on the other hand, has two long spines on the same margin (Fig. 32*C*). Alcock (1901, p. 252) described the basal segment of the antennule as having " only one of its spines, namely, that at the antero-external angle, long ". The antennal peduncle has the disto-lateral angle of the second segment produced into a spine. A small stout spine is present between the base of the antennal peduncle and the eye-stalk, immediately below the oblique frontal margin of the carapace.

The merus of the third maxilliped is serrated on its outer margin and produced into two large spines on the proximal inner one (Fig. 32*D*).

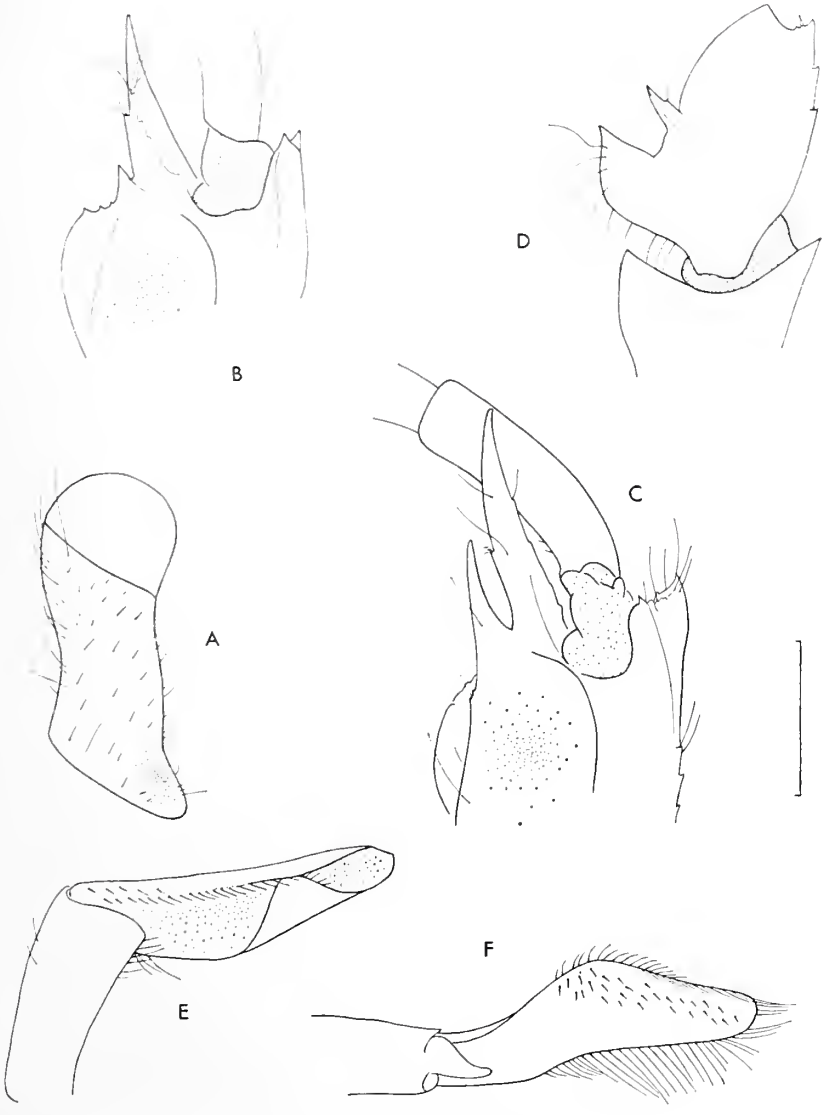


FIG. 32. *Munidopsis* (*Munidopsis*) *dasypus* Alcock. A. Right eye of female, lateral view. B. Part of left antennule of male, dorsal view. C. Same of female. D. Middle part of left third maxilliped of female. E. Right first pleopod of male, dorsal view. F. Distal part of right second pleopod of male, ventral view. (Scale = 1 mm.)

The chelipeds and the walking legs have been fully described by the earlier authors. It may be pointed out here that the chelipeds are equal in the male and asymmetrical in the female where the left one exceeds the right by ten millimetres.

The endopods of the first two pairs of male pleopods are illustrated in Figs. 32*E*, *F*.

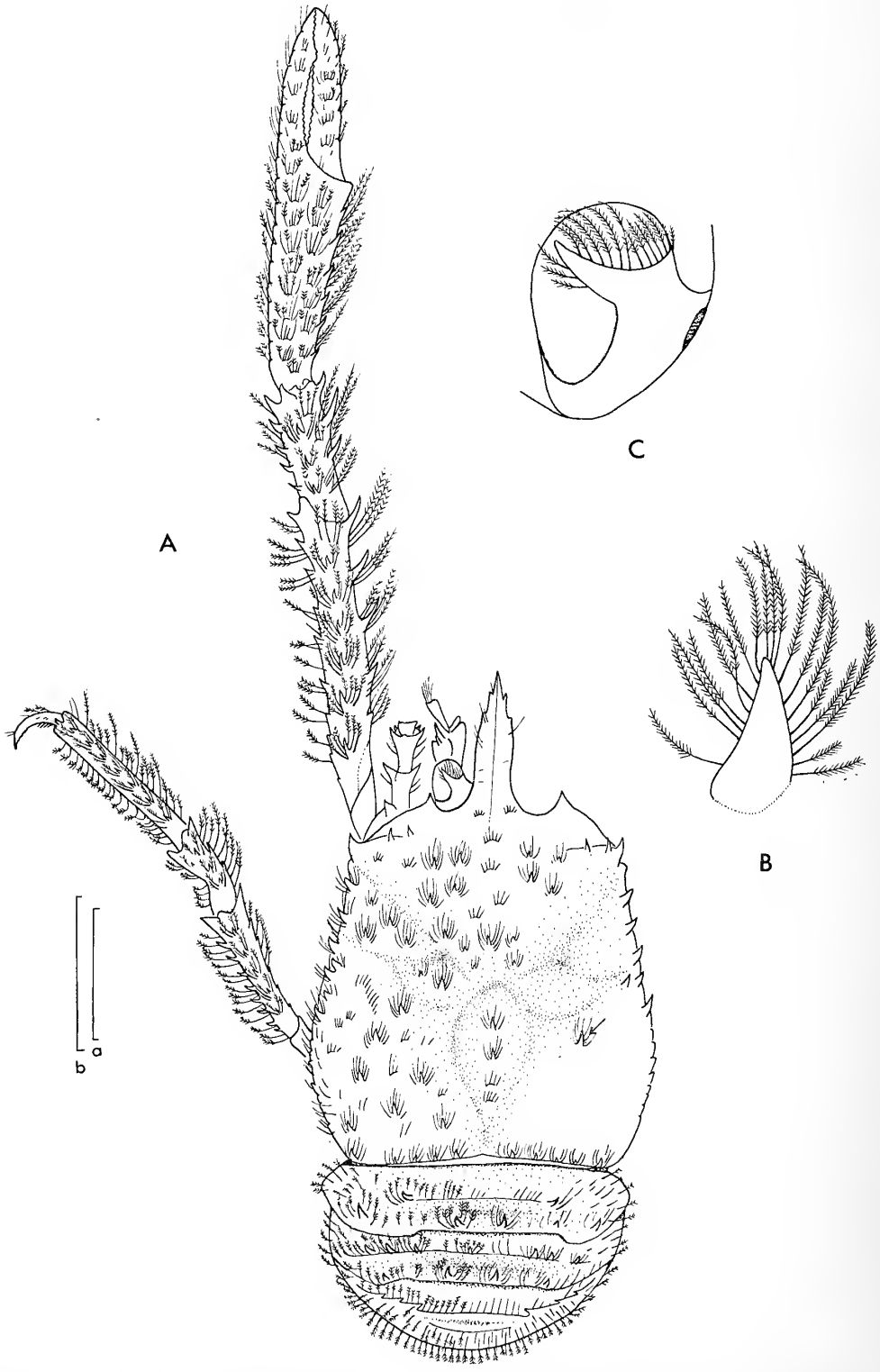


FIG. 33. *Munidopsis* (*Munidopsis*) *spinihirsuta* Lloyd. A. Dorsal view of female (scale *a* = 5 mm.). B. Single spine of carapace further enlarged. C. Left eye (scale *b* = 1 mm.).

Munidopsis (Munidopsis) spinihirsuta Lloyd

(Figs. 33, 34)

Munidopsis spinihirsuta Lloyd, 1907, p. 12.

Occurrence : *South Arabian coast :* St. 54, Agassiz trawl, 1046 metres, 8 males (c.l. + r. = 22 mm., ch.l. = 18–45 mm.) ; 7 females (c.l. + r. = 12–18 mm., ch.l. = 19–33 mm.).

Distribution : Arabian Sea.

Description : The brief description of *M.* (*Munidopsis*) *spinihirsuta* given by Lloyd was based on three small males collected from the Arabian Sea. The " John Murray " Expedition took fifteen specimens, seven of which are females. Two females are ovigerous, their carapace lengths being 12 mm. and 17·5 mm. respectively.

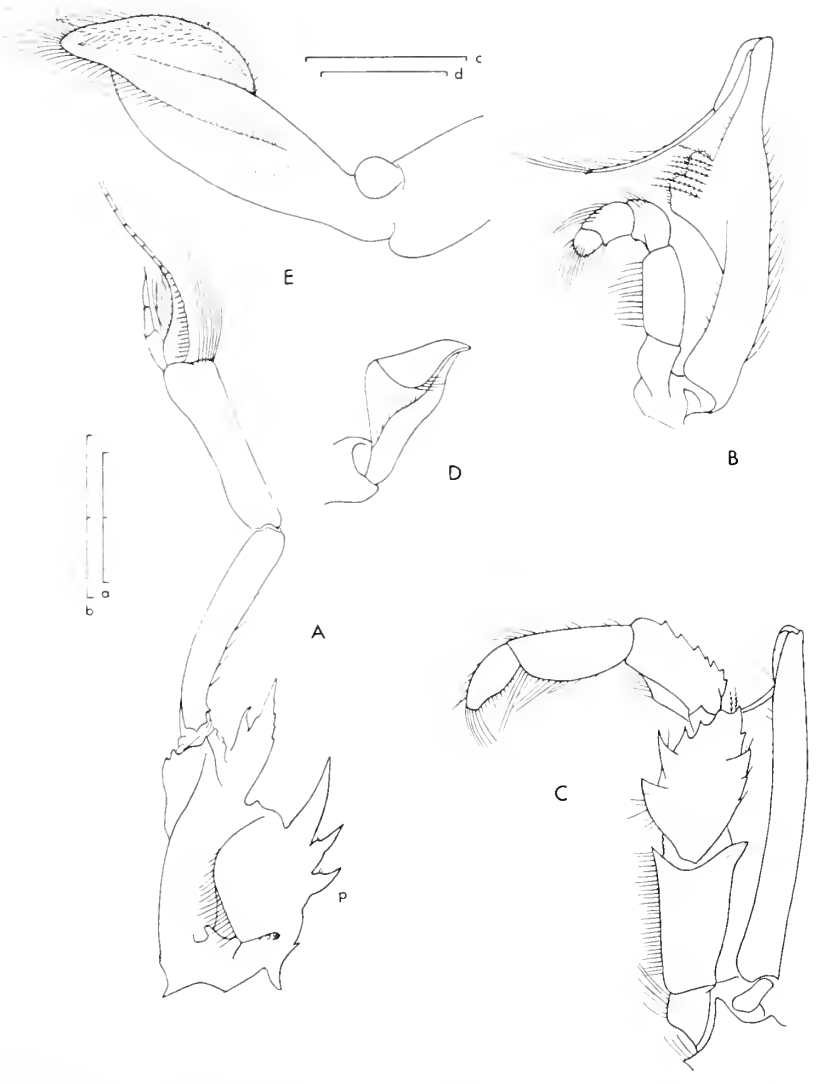


Fig. 34. *Munidopsis* (*Munidopsis*) *spinihirsuta* Lloyd. A. Right antennule, dorsal view (scale *b* = 2 mm.). B. Left second maxilliped (scale *a* = 2 mm.). C. Left third maxilliped (scale *a*). D. Endopod of left first pleopod of male, dorsal view (scale *d* = 1 mm.). E. Distal part of left second pleopod of male, ventral view (scale *c* = 1 mm.).

The dorsal view of the larger ovigerous female is illustrated in Fig. 33*A*. The integument is crisp, unlike that of most members of the sub-family Munidopsinae. The carapace is covered by large well separated spines ; each spine is flanked on either side by long hairs each with the distal half plumose (Fig. 33*B*). The rostrum is broadly triangular, the lateral margins are serrated near the tip which is upcurved. A median carina extends over the dorsal surface of the rostrum. The second to fourth abdominal terga are each provided with two transverse carinae. The anterior carina of the second tergum is short, with a spine at each lateral end ; the posterior carina is long, extends to the corresponding pleura and is provided with four to five spines. The anterior carinae on each of the two following terga are similar to the posterior one of the second tergum, that is each is armed and extends on to the respective pleura. The posterior carina of the third tergum is short and has about four spines, the same carina of the fourth tergum is unarmed and rather obscure, the spines are similar to those of the carapace. The last two abdominal terga are unarmed. The dorsal surface of all the abdominal terga and of the telson is pubescent. In the males the lateral margins of the telson are fringed with thick, amber coloured setae.

The eye is rather small and the peduncle is produced over the cornea as a curved spine, fringed with plumose hairs (Fig. 33*C*).

The basal segment of antennule has several spines as illustrated in Fig. 34*A*. In some specimens the proximal spine *p* may be bifid. The outer distal angle of the basal segment of the antenna is produced into a spine ; both the outer and inner distal angles of the second segment are also produced into fairly long spines ; the distal margin of the following segment has a whorl of four spines.

The second and third maxillipeds are represented in Fig. 34*B*, *C*.

The chelipeds are long and slender, measuring a little less than twice the length of the carapace including rostrum. The ischium has a small spine on its outer distal angle (not visible in the figure). Three rows of spines extend over merus and carpus, and the palm has spines only on its inner margin. All the segments except the ischium are hairy. The walking legs are likewise very spiny and hairy ; there are no spines on the posterior margin of the propodus and the same margin of the dactylus is finely serrated. There are no epipodites on the chelipeds or any of the legs.

The first pleopod of the male has a membranous endopod which is curled dorsally (Fig. 34*D*). The endopod of the second pleopod, which is represented in Fig. 34*E*, shows some resemblance to that of *Galacantha rostrata* (cf. Fig. 24*E*).

Munidopsis (Munidopsis) scobina Alcock

(Fig. 35)

Munidopsis scobina Alcock, 1894, p. 330.
Munidopsis scobina, Alcock, 1901, p. 254 ; Ill. Zool. Investigator, Crust., pl. XIII, fig. 1.

Occurrence : *South Arabian coast :* St. 54, Agassiz trawl, 1046 metres, several specimens of both sexes (c.l. + r. = 8–19 mm., ch.l. = 10–27 mm. respectively).

Distribution : Indian Ocean.

Descriptive remarks : The " John Murray " specimens differ constantly from Alcock's description in having the body and appendages hairy and the antero-lateral margins of the carapace more convergent than illustrated (Alcock, 1901, pl. XIII, fig. 1). The branchial region has several short transverse ridges. The second to fourth abdominal terga are as described for the type. In the " John Murray " specimens the spinate crests on the second and the third terga have four to eight

spines. The anterior crest of the fourth tergum has two to four spines ; on the posterior crest there are only one or two spines which may even be reduced or absent in a few specimens.

The eye is illustrated in Fig. 35*A*. The spines on the basal segment of the antennule are as represented in Fig. 35*B* (except in one instance where the proximal spine of the outer margin is wanting in the right appendage). The spines on the antennal peduncle are " remarkably distinct " as pointed out by Alcock (1901, p. 254) ; the ventral view is represented in Fig. 35*C* ; dorsally the distal margin of each of the second and third segments has a median spine. The inner distal angle of the ischium of the third maxilliped is produced into a spine ; the inner margin of the merus has two spines (Fig. 35*D*) except in a young female where only one spine is present.

The first pair of pleopods in the male is very similar to that of *Munidopsis* (*Munidopsis*) *dasypus* (cf. Fig. 32*E*) ; the second pair, on the other hand, shows some resemblance to that of *M.* (*Munidopsis*) *spinihirsuta*, the left endopod is illustrated in Fig. 35*E*.

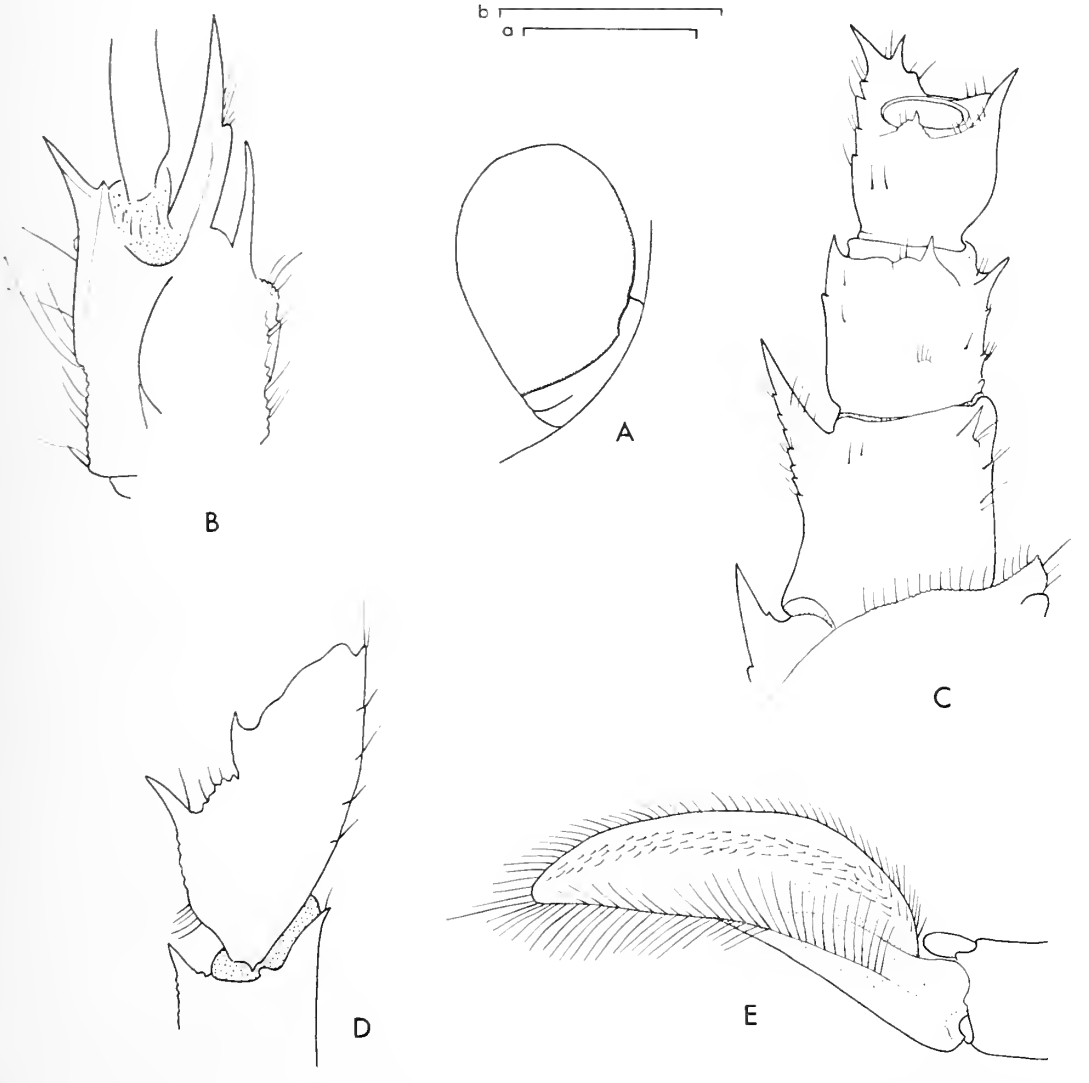


FIG. 35. *Munidopsis* (*Munidopsis*) *scobina* Alcock. A. Left eye (scale *a* = 1 mm.). B. Right antennule, dorsal view (scale *b* = 1 mm.). C. Right antennal peduncle, ventral view (scale *b*). D. Middle part of left third maxilliped (scale *a*). E. Distal part of left second pleopod of male, ventral view (scale *b*).

Munidopsis (Munidopsis) stylirostris Wood-Mason

(Fig. 36)

Munidopsis stylirostris Wood-Mason, 1891, p. 201.
Munidopsis stylirostris, Alcock, 1894, p. 328 ; 1901, p. 256 ; Ill. Zool. Investigator, Crust., pl. XIII, fig. 6.

Occurrence : *Gulf of Aden :* St. 185, Agassiz trawl, 2000 metres, 1 ovig. female (c.l. + r. = 15 mm., ch.l. = 20 mm.).

Distribution : Indian Ocean.

Descriptive remarks : The single specimen of *M.* (*Munidopsis*) *stylirostris* taken by the " John Murray " Expedition is a female. It differs from Alcock's description as follows :

The lateral margins of the carapace are parallel throughout their length and, instead of diverging anteriorly (Alcock, 1901, p. 256), they appear to be somewhat convergent near the antero-lateral angles. The rugosities of the gastric region, mentioned by Alcock, have finely ctenate anterior

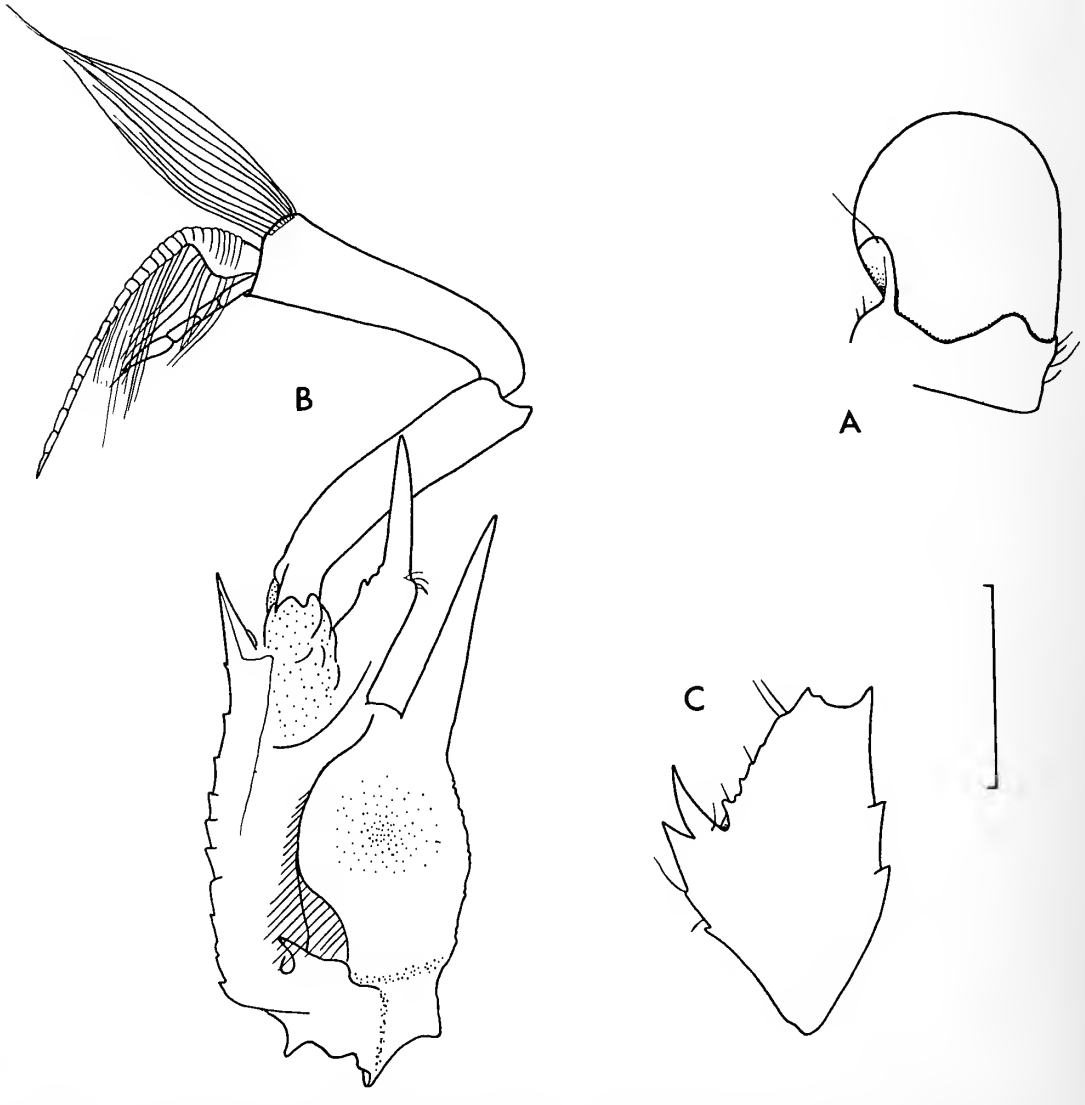


Fig. 36. *Munidopsis* (*Munidopsis*) *stylirostris* Wood-Mason. A. Right eye, lateral view. B. Right antennule, dorsal view. C. Merus of left third maxilliped. (Scale = 1 mm.)

margins ; similar rugosities are also present between the two divisions of the cervical groove. Posterior to the cervical groove the rugosities become more numerous but less emphasized. Moreover, only the second and third abdominal terga have " microscopically ctenate crests " (1901, p. 257) on either side of the transverse groove ; the crenulations on the posterior crest of the third tergum are very indistinct. The crests on the fourth tergum are quite smooth.

Alcock stated that the " thoracic legs, except the ischiopodite of the first pair, are almost devoid of hairs " (1901, p. 257). In the illustration, however, the artist depicts long fine hairs on all the legs (Pl. XIII, Fig. 6) and in the " John Murray " specimen all the thoracic legs are provided with rather long hairs at least some of which appear to be plumose. The hairs on the inner margin of the merus, carpus and the palm of the cheliped are quite dense ; the walking legs are less hairy.

The right eye is illustrated in Fig. 36*A*. The cornea bulges medially and on the same side the short eye-stalk is produced anteriorly into a scale. The basal segment of the antennule has two outer and one inner distal spine (Fig. 36*B*). The antennal peduncle shows a striking similarity to that of *M. scobina* (cf. Fig. 35*C*) but differs in being less spiny. The outer distal angle of the basal segment is not developed into a spine as in *M. scobina* but, like the inner distal angle, this angle is also produced into an acute triangular process. The penultimate segment has only a sharp projection on its outer distal angle. The distal outer process of the ultimate segment is not so sharp and spiny. Moreover, there are no dorsal spines on the second and the third segments.

The merus of the third maxilliped has a pair of characteristic spines on its inner margin (Fig. 36*C*).

Munidopsis (Munidopsis) wardeni Anderson

(Fig. 37*A–C*)

Munidopsis wardeni Anderson, 1896, p. 99.
Munidopsis wardeni, Alcock, 1901, p. 257 ; Ill. Zool. Investigator, Crust., pl. LV, fig. 1 ; Doflein & Balss, 1913, p. 153.

Occurrence : *Zanzibar area :* St. 108, Agassiz trawl, 786 metres, 1 ovig. female (c.l. + r. = 19 mm., ch.l. = 38 mm.).

St. 122, otter trawl, 732 metres, 1 female (c.l. + r. = 17 mm., ch.l. = 30 mm.).

Maldive area : St. 143, Agassiz trawl, 797 metres, 1 female (c.l. + r. = 11·5 mm., ch.l. = 17 mm.).

Distribution : Indian Ocean.

Descriptive remarks : The three females of *M. wardeni* taken by the " John Murray " Expedition agree with the " Investigator " specimens except that the cervical groove is weak and the lateral spines in relation to it (Alcock, 1901, p. 258) are wanting. The second to fourth abdominal terga have each a transverse groove the margins of which are raised as finely headed carinae. In the female from St. 122 both the anterior and posterior carinae of the second and third tergum and only the anterior carina of the fourth are armed with median spines. In the largest female only the anterior carina of each of the three terga is armed ; in the youngest specimen even the anterior carina of the fourth tergum is unarmed, only the anterior carina of second and third terga being armed. In all the three specimens the posterior carina of the fourth tergum is less conspicuous than the others, which are very prominent.

The spinosity of the basal segment of the antennule and the merus of the third maxilliped is illustrated in Fig. 37*A*, *B*. The right eye is shown in Fig. 37*C*. The antennal peduncle differs from that of *M.* (*Munidopsis*) *stylirostris* only in having a smaller spine at the outer angle of the second segment.

REMARKS : The " Valdivia " specimen referred to this species by Doflein and Balss (1913, p. 153) has no spines on the abdominal terga and McGilchrist (1905, p. 245) gave this as a character for his *M. wardeni* var. *andamanica*. This suggests that these two may be synonymous although Doflein and Balss did not appear to accept the variety as valid.

Munidopsis (Munidopsis) wardeni Anderson *mabahiss* var. nov.

(Figs. 37*D–F*, 38)

OCCURRENCE : *Gulf of Aden :* St. 34, Agassiz trawl, 1022 metres, 5 males, 5 females (one ovigerous).

Maldive area : St. 143, Agassiz trawl, 797 metres, 4 males, 1 female.

REMARKS ON MATERIAL : From St. 34 the largest specimen is a male measuring 26 mm. in carapace length, including rostrum, and the left, or larger, of the unequal chelipeds is 67 mm. long. An ovigerous female of the same carapace length has the larger cheliped measuring only 49 mm. ; the smallest specimen is a female (c.l. + r. = 9 mm., ch.l. = 19 mm., symmetrical). From St. 143 the largest specimen is again a male with c.l. + r. = 21 mm. and the symmetrical chelipeds are 52 mm. long. The smallest is a female with c.l. + r. = 15 mm. and the symmetrical chelipeds measure 29 mm.

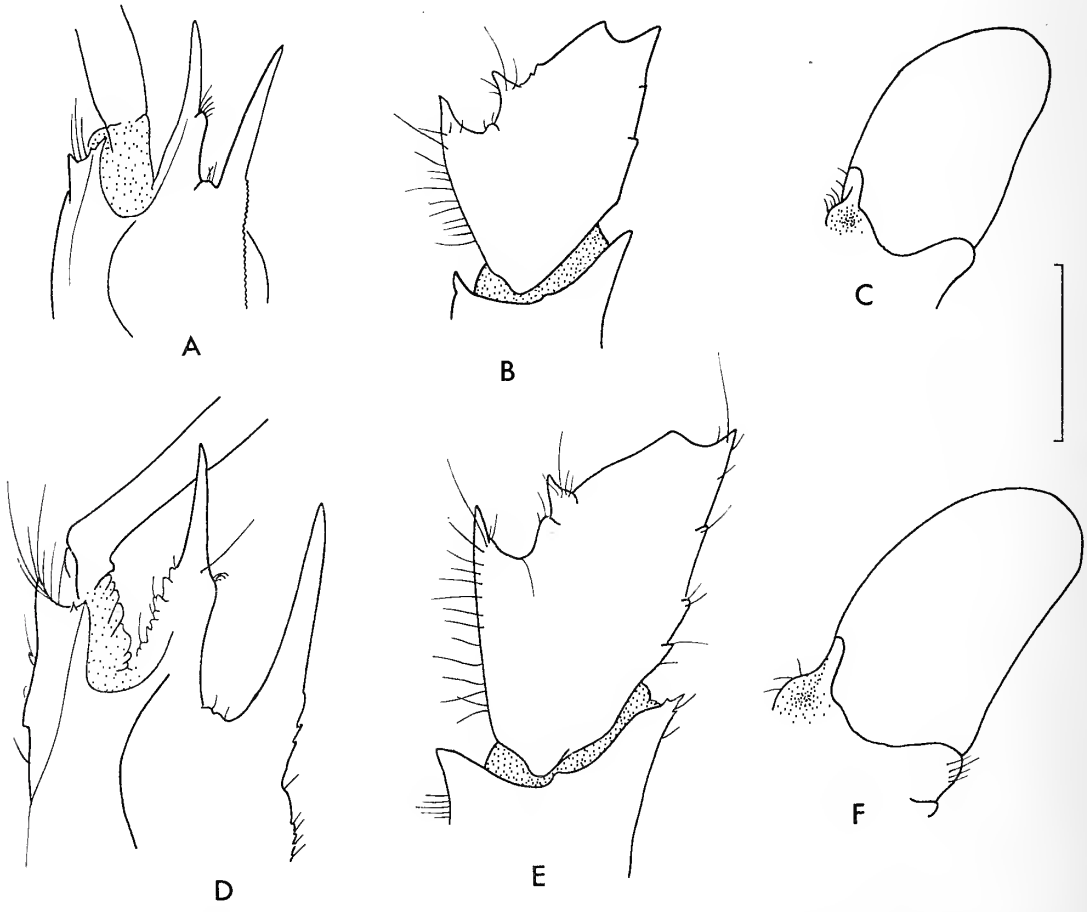


FIG. 37. *Munidopsis* (*Munidopsis*) *wardeni* Anderson. A. Part of right antennule, dorsal view. B. Middle part of left third maxilliped. C. Right eye, lateral view. *Munidopsis* (*Munidopsis*) *wardeni mabahiss* var. nov. D, E and F as for A, B and C of *wardeni*. (Scale = 1 mm.)

DESCRIPTIVE REMARKS : *M.* (*Munidopsis*) *wardeni* var. *mabahiss* differs from *M. wardeni* in being more hairy and in having several spines on the carapace. The gastric region is armed with a pair of anterior spines and a row of four to six mid-dorsal spines, some of which are bifid or even trifid (Fig. 38*A*). The cardiac area has a prominent spiny crest. The posterior margin of the carapace is raised and has one to several spines in the middle only. The second and third abdominal terga have each a transverse groove, both margins of which are raised and armed with three to six median spines. The anterior margin of the fourth tergum is armed in a similar fashion, but the posterior margin may have one small spine or may be totally unarmed. In young specimens the crest on the cardiac region and the posterior border of the carapace are unarmed. The spines on the abdominal terga are also reduced in size and number.

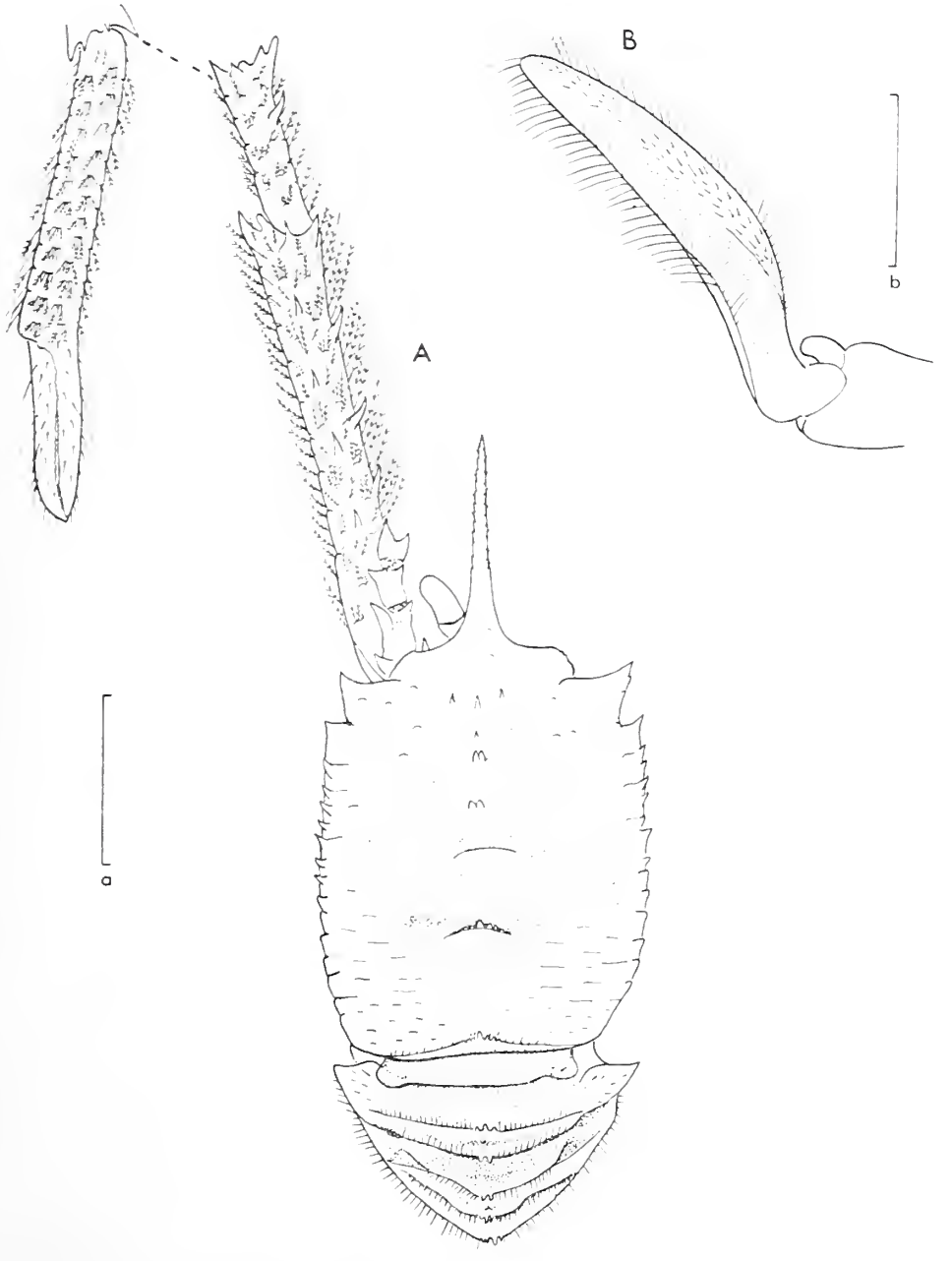


FIG. 38. *Munidopsis* (*Munidopsis*) *wardeni mabahiss* var. nov. A. Male, dorsal view (scale $a = 5$ mm.). B. Distal part of left second pleopod of male, ventral view (scale $b = 1$ mm.).

The armature of the antennule, and of the merus of the third maxilliped is very similar to that of *M. wardeni* (Figs. 37*D*, E). The antennal peduncle of the two varieties are also very similar. The eye of *M. wardeni* var. *mabahiss* is illustrated in Fig. 37*F*.

In some specimens the carpus of the cheliped has a conspicuous spine on its inner margin (Fig. 38*A*).

In the males both the first and second pairs of pleopods are developed. The first pleopod shows a strong resemblance to that of *M. dasypus* except that the apex is here rather trancated and not so acute (cf. Fig. 32*F*). The endopod of the second pleopod is long and slender (Fig. 38*B*).

In my opinion the sum total of these differences seems to justify the recognition of a separate variety.

Sub-genus *GALATHODES*

KEY TO THE DETERMINATION OF THE INDIAN OCEAN SPECIES OF THE SUB-GENUS *GALATHODES*

I. Epipodites present on the chelipeds only ; posterior border of carapace and anterior border of second to fourth terga spinose . . . . . ***M. (Galathodes) regia*** Alcock and Anderson

II. No epipodites on chelipeds or legs ; posterior border of carapace and abdominal terga without spines.
M. (Galathodes) trifida Henderson

Munidopsis (Galathodes) regia Alcock and Anderson

(Fig. 39)

Munidopsis regia Alcock and Anderson, 1894, p. 168.
Munidopsis (*Galathodes*) *regia*, Alcock, 1901, p. 261 ; Ill. Zool. Investigator, Crust., pl. XI, fig. 1 ; Doflein and Balss, 1913, p. 156, text-fig. 23.
Munidopsis triaena Alcock and Anderson, 1894, p. 168.
Munidopsis (*Galathodes*) *triaena*, Alcock, 1901, p. 261 ; Ill. Zool. Investigator, Crust., pl. XI, fig. 5.

OCCURRENCE : *Maldive area :* St. 145, Agassiz trawl, 494 metres, 2 males (c.l. + r. = 29 and 43 mm., larger ch.l. = 46 and 74·5 mm. respectively) ; 1 ovig. female (c.l. + r. = 50 mm., ch.l. = 85 mm.).

DISTRIBUTION : Indian Ocean.

DESCRIPTIVE REMARKS : The " John Murray " specimens agree well with the description given by Alcock (1901, p. 261). Alcock described the carapace as being " traversed fore and aft in the middle line by a raised row of coarse granules or spinules, of which one in the postcardium is constant " (1901, p. 261). In the " John Murray " specimens there are three or four spinules which gradually increase in size posteriorly ; the largest is situated on the cardiac region and the anterior small one is placed immediately behind and between the large gastric pair.

The cornea is globular and the eye-stalk is prolonged medially (Fig. 39*A*). The basal segment of the antennule is furnished with three spines (Fig. 39*B*). Each of the basal two segments of the antenna have their inner and outer distal angles produced into large spines.

The merus of the third maxilliped (Fig. 39*C*) as described by Alcock is armed " on the inner border, near the proximal end, with two very large unciform spines, and, on the outer border, distally, with a strong spine " (p. 262). In this respect the " John Murray " specimen agrees with the type and differs from the " Valdivia " specimen where the two spines of the inner border are widely separated (Doflein and Balss, 1913, text-fig. 23).

In the males the chelipeds are unequal ; the larger may be on either side and exceeds the smaller by the length of the dactylus.

The first and second pleopods of the males are slender. The anterior margin of the first endopod is curled dorsally and the same surface is furnished with a row of hairs along the dotted lines represented in Fig. 39*D*. The second pleopod is represented in Fig. 39*E*.

Munidopsis (Galathodes) trifida Henderson

(Fig. 40)

Munidopsis trifida Henderson, 1885, p. 415.
Munidopsis trifida, Henderson, 1888, p. 156, pl. xvi, fig. 2 ; Alcock and Anderson, 1894, p. 168.
Galathodes trifidus, Milne Edwards and Bouvier, 1894, p. 279.
Munidopsis (*Galathodes*) *trifida* Alcock, 1901, p. 260 ; Ill. Zool. Investigator, Crust., pl. LXX, fig. 1.

Occurrence : *South Arabian coast :* St. 54, Agassiz trawl, 1046 metres, 3 females (c.l. + r. = 10·5, 20 and 21 mm.—largest with eggs).

Gulf of Aden : St. 184, Agassiz trawl, 1270 metres, 1 male (c.l. + r. = 21 mm., ch.l. = 42 mm.).

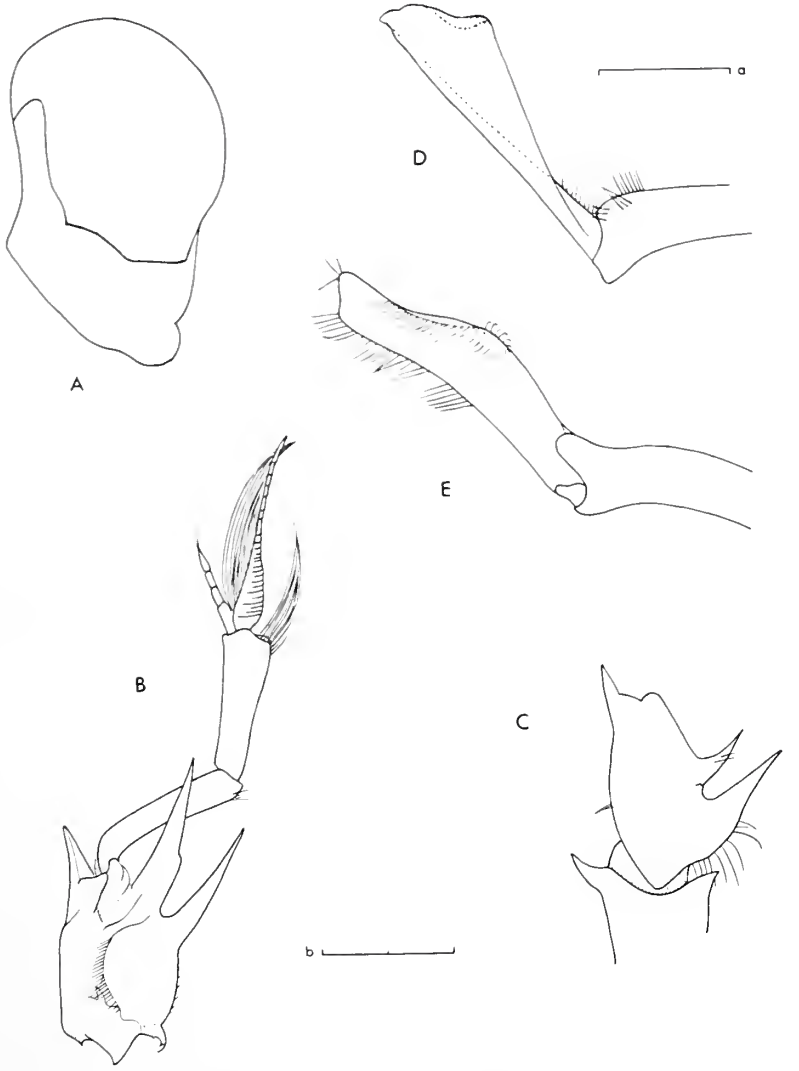


Fig. 39. *Munidopsis* (*Galathodes*) *regia* Alcock & Anderson. A. Right eye, lateral view (scale *a* = 1 mm.). B. Right antennule, dorsal view (scale *b* = 2 mm.). C. Merus of right third maxilliped (scale *b*). D. Left first pleopod of male, ventral view (scale *a*). E. Left second pleopod of male, ventral view (scale *a*).

DISTRIBUTION : Atlantic ; Indo-Pacific.

DESCRIPTIVE REMARKS : The four " John Murray " specimens, one male and three females, agree with the earlier descriptions of the species except in some details of the spinosity of the chelipeds and walking legs. In these specimens the chelipeds are missing or incomplete except the left one of the male where the ischium has two distal spines, a large dorsal and a smaller ventral one. The merus is armed with three longitudinal rows of spines, a ring of four spines distally and a few spinules on its ventral surface (in Alcock " ischium " is used by mistake). The carpus has two rows of spines dorsally and a ring of spines on the distal margin of which four are dorsal and two ventral. Both the outer and inner margins of the palm are spinose. The fingers are a little shorter than the palm and the opposed margins are nearly in contact throughout their length. There is no proximal excavation and molariform tooth such as are described and figured for the " Investigator " male (Alcock, 1901, p. 260).

In the walking legs the merus is armed with a row of spines on the anterior margin, in the third one there is an additional row on the dorsal surface ; the posterior margin has a single distal spine.

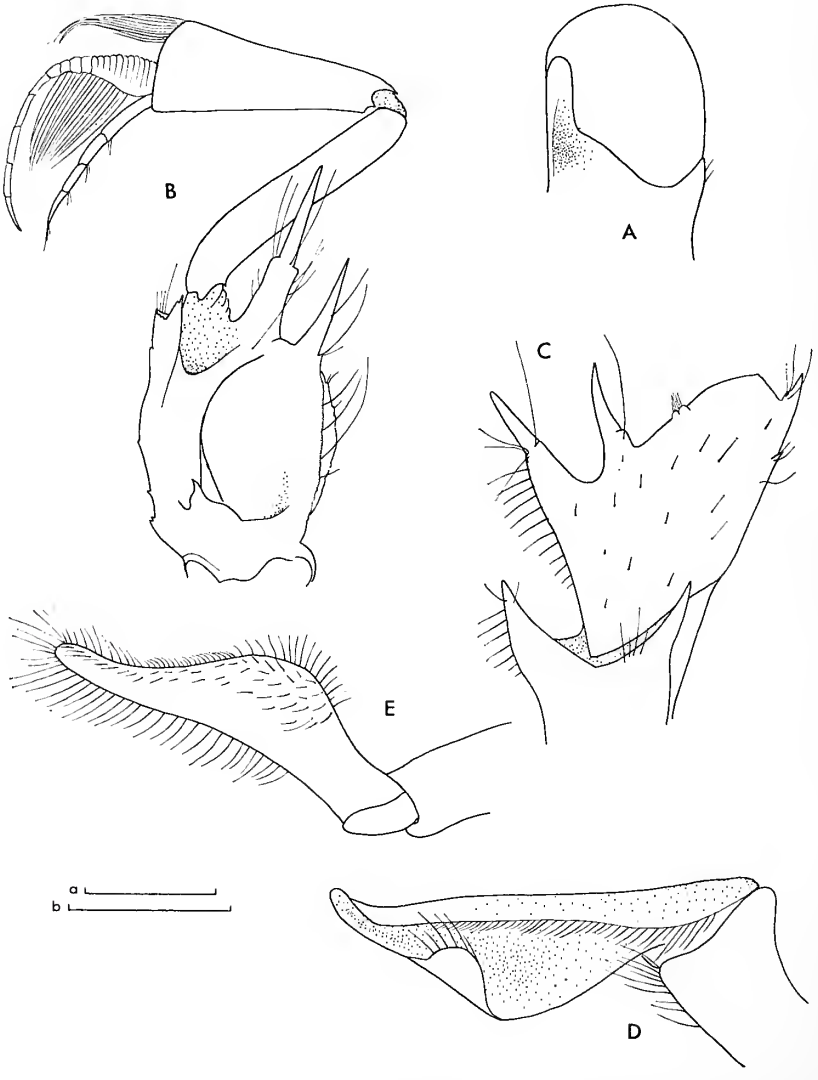


FIG. 40. *Munidopsis* (*Galathodes*) *trifida* Henderson. A. Right eye, lateral view (scale *b* = 1 mm.). B. Right antennule, dorsal view (scale *a* = 1 mm.). C. Middle part of left third maxilliped (scale *a*). D. Distal part of left first pleopod of male, dorsal view (scale *b*). E. Distal part of left second pleopod of male, ventral view (scale *b*).

The anterior margin only of the carpus is spiny. The posterior margin of the dactylus is not only serrated but is also provided with horny spines.

The eye is illustrated in Fig. 40*A*. The basal segment of the antennule has two strong external spines (Fig. 40*B*). The antennal peduncle differs from that of *M. regia* in having only one (outer) spine on the distal margin of the second segment.

The ischium of the third maxilliped has two strong distal spines. The merus has two large spines on its inner margin and one smaller one on the outer distal angle (Fig. 40*C*). In the male the proximal spine on the inner border of the merus is considerably broadened at the base.

The first and second pleopods of the male are illustrated in Figs. 40*D*, *E*. They are remarkable in having long tapering apices.

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JOHN MURRAY EXPEDITION

1933-34

SCIENTIFIC REPORTS

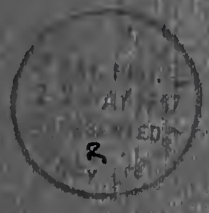
VOLUME XI, No. 3

THE DEEP-SEA BIVALVIA

BY

J. KNUDSEN

Zoological Museum of the University, Copenhagen



TRUSTEES OF THE BRITISH MUSEUM (NATURAL HISTORY)

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THE DEEP-SEA BIVALVIA

BY

J. KNUDSEN

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ABSTRACT

THE present paper deals with 44 species of deep-sea bivalves from the Indo-West Pacific area, of which 39 species were obtained by the "*John Murray*" *Expedition* and belong to the British Museum (Nat. Hist.). Additional material, mainly from the collections of the Zoological Museum, Copenhagen, has been included, comprising five species not contained in the "*John Murray*" *Expedition* material. Of the 44 species, of which 12 are represented by shells only, six are described as new: *Tindaria murrayi*, *Spinula filatovae*, *Amussium sewelli*, *Pitar sewelli*, *Xylophaga murrayi* and *Lyonsiella murrayi*.

All species have been described and figured and whenever possible some observations have been made on the soft parts. Some taxonomic revision has been undertaken and several identifications have been checked by comparison with type specimens. On the basis of previous records and the present material the horizontal and vertical distribution as well as the temperature range of each individual species has been worked out.

Four of the species treated turn out to be widely distributed abyssal species known from all three oceans: *Acar asperula*, *Limopsis pelagica*, *Amussium meridionale* and *Abra profundorum;* two additional species: *Tindaria murrayi* n.sp. and *Spinula filatovae* n.sp. are possibly abyssal. Four species are recorded from the Red Sea: *Nucula donaciformis*, *Amussium steindachneri*, *Cuspidaria brachyrhynchus*, *C. steindachneri*. With the exception of *C. brachyrhynchus*, they are known also from outside the Red Sea. The remaining 34 species are bathyal and with the exception of two, *Amygdalum politum* (known also from the Atlantic) and *Cryptodon bisecta* (known also from the N.E. Pacific) are confined to the Indo-West Pacific area. Ten of these species have a known range from E. Africa (10-30° S.) to Japanese waters. The remaining species have a less extensive range, but two more species occur from other parts of the Indian Ocean to Japanese waters, and ten species have a range covering the western part of the Indian Ocean and the S.E. Asian waters. It is concluded that as far as the bathyal bivalves are concerned there seems to be an Indo-West Pacific fauna having the same extension as the adjacent shallow water fauna. The available evidence would seem to indicate that this fauna is distinct from the bathyal bivalve faunas of neighbouring areas (New Zealand-Tasman Sea, Australian Bight and South Africa). Some indication was found that the bathyal species tend to occur in shallower water around Japan as compared to the Indian Ocean-S.E. Asian waters. It would appear from the available data that the upper temperature limit of the bathyal fauna should rather be put around 12° C than at 10° C as sometimes suggested.

A survey of the feeding of the species studied has been made. Twenty of the 39 bathyal species proved to be carnivores. A carnivorous habit was found in seven species of Pectinidae (*Propeamussium* and *Amussium*) and 13 Septibranchia, both groups living on meiobenthos. It is suggested that the high proportion of carnivores is not representative of the bivalve fauna, as the sampling techniques of the expedition probably favoured the capture of larger species at the expense of smaller ones, which would have included numerous taxodont deposit feeders. However, it is believed that the large carnivorous bivalves must play an important ecological rôle in the bathyal benthic community of the region. The food uptake of *Amussium* is discussed.

Measurements of prodissoconchs, and of sizes of mature eggs, in 32 species of the present collection, indicated a dominance of species having a lecithotrophic development with a short pelagic larval stage (i.e., 20 species, of which five are abyssal). Direct development was observed in nine species (all bathyal), while three species (one of which is abyssal) had pelagic development.

Finally a survey of the deep-sea bivalves of the "*Investigator*" *Expedition* (1884-1913) is given with some notes on the material.

INTRODUCTION

HISTORICAL REVIEW

The first expedition to undertake deep-water dredgings in the tropical part of the Indian Ocean was the *R.I.M.S.* "*Investigator*", which worked from 1884 to 1914. During this period a large number of dredgings at depths greater than 400 m were carried out, and bivalves were obtained at some 66 stations in the Arabian Sea and the Bay of Bengal. The material was reported in the following papers: Wood-Mason & Alcock 1891a, 1891b; E. A. Smith 1893, 1894, 1895a, 1895b, 1896, 1899, 1904, 1906; Bavay 1905 and Sowerby 1888, 1894. A number of the species were mentioned and figured in the account of the expedition written by Alcock: "A naturalist in Indian Seas" (1902). Many of the species listed in the above reports were excellently figured in "*Illustrations of the Zoology of the R.I.M.S. 'Investigator'* " **1–6** (1897–1909) issued by Alcock & Anderson (1897, 1898), Alcock & McArdle (1901), Alcock, Annandale & McGilchrist (1907) and Annandale & Stewart (1909). Some "*Investigator*" specimens were studied by Prashad (1932b, 1933). Since the "*Investigator*" bivalves were published in so many papers, by several authors and over a long period, Winckworth (1940) listed all the "*Investigator*" molluscs giving for each species references to the papers in which it was mentioned and references to figures. Unfortunately, none of the many papers dealing with the "*Investigator*" bivalves distinguished between specimens alive at capture and "dead" shells. The descriptions are generally brief and rather often the data on locality, depth, etc. are not complete. However, the figures are generally very good although a few species were not figured. The main part of the collection is kept in the Zoological Survey of India, Calcutta, but according to Dr. A. S. Rajagopal (*in litt.* 10 November, 1965) the collection is now in rather poor condition (owing to damage by flooding in 1943). A number of samples of "*Investigator*" deep-sea bivalves are in the British Museum (Nat. Hist.); the U.S. National Museum, Washington, D.C., and the Zoological Museum, Copenhagen. Material in the latter museum comprises three samples which were included in the present study.

It should be mentioned that the "*Challenger*" *Expedition* (1873–76), carried out some deep-sea dredging in the subantarctic region of the Antarctic Ocean between S. Africa and Australia, but the expedition did not work in the Indian Ocean proper.

The "*Pola*" *Expedition* (1895/6 and 1897/8) collected nine species of bivalves at 25 stations at depths greater than 400 m in the Red Sea, this material being very carefully described and figured by Sturany (1901). The material of the "*Pola*" *Expedition* was deposited in the Naturhistorisches Museum, Vienna, but Dr. O. Paget (*in litt.* 6 February, 1963) informed me that the bivalve material could not be located, suggesting that it was either destroyed during World War II or sent out to a specialist and never returned.

The "*Valdivia*" *Expedition* (1898/99) undertook deep-sea dredgings at some 25 stations in the Indian Ocean, mainly concentrating on an area around Zanzibar (E. Africa) and the region off the S.W. coast of Sumatra, besides a few stations in the southern part of the Indian Ocean. The bivalves were studied by Thiele & Jaeckel (1931). The collection is kept in the Institut f.spezielle Zoologie u.zoologisches Museum d. Humboldt-Universität zu Berlin.

Mr. F. W. Townsend carried out numerous dredgings in the Persian Gulf, the Gulf of Oman and the Arabian Sea during the years 1893 to 1906. The bivalves, of which a couple of samples came from deep water, were reported on by Melvill & Standen (1907), Melvill (1928). Townsend (1928) gave an account of the dredging activities.

The "*Siboga*" *Expedition* (1899/1900), although working mainly in the S.E. Asian waters, worked a few deep-sea stations in the eastern part of the Indian Ocean, off Flores and Timor. The material was studied by Pelseneer (1911), who dealt exclusively with the anatomy of several species; by Dautzenberg & Bavay (1912), who studied the Pectinidae; and by Prashad (1932a), who treated the main part of the bivalves excepting the Pectinidae. The "*Siboga*" material is in the Zoologisch Museum, Amsterdam.

Off the S.E. coast of Africa a number of deep-sea stations have been worked by research vessels of the South African government from 1895 to the present day ("*Pieter Faure*", "*Pickle*" and "*Africana II*"). The deep-sea bivalves were studied by Sowerby (1904) and Barnard (1963b, 1964a), the latter paper giving a complete survey of the bivalves (including the deep-sea species) of the region. Barnard (1964b) gave an historical account of the work done by the trawler "*Pieter Faure*". The main part of the collections are kept in the South African Museum, Cape Town.

Beliaev & Vinogradova (1961) and Filatova (1961) reported on a few bivalves obtained by the *Vityaz Expedition* at abyssal and hadal depths in the Sunda (Java) Trench.

A number of bathyal dredge hauls (down to a depth of about 600 m) have been carried out in the Australian Bight. The molluscs, including the bivalves, were studied by Verco (1907, 1908).

MATERIAL AND METHODS

The bivalve material from below 400 m depth obtained by the "*John Murray*" *Expedition* comprises 67 samples, representing 39 species of which six are described as new. The chart (fig. 1) shows the stations at which the material was collected. Out of the 39 species obtained, 10 were represented by shells only. The majority of the remaining part of the collection was preserved in alcohol and the state of preservation is generally very good. For further details on the expedition reference is made to the Introduction and Station List of the "*John Murray*" *Expedition* (Sewell 1935). Besides the collection of the "*John Murray*" *Expedition*, additional material from the Zoological Museum, Copenhagen, has been included in the present report, viz.,

1. *The* "*Investigator*" *Expedition* ("*Investigator*", List of Stations 1884–1913), – two samples, two species.
2. *Dr. Th. Mortensen's Pacific Expedition* 1913–1916 (unpublished, mimeographed station list in the Zoological Museum, Copenhagen), – two samples, two species.
3. *The Danish Expedition to the Kei Islands* 1922, Dr. Th. Mortensen (Th. Mortensen: The Danish Expedition to the Kei Islands 1922. – Vidensk. Medd. fra dansk. naturh. Foren. 76:55–99), – ten samples, eight species.
4. *The Java-South Africa Expedition* 1929–30, Dr. Th. Mortensen (unpublished, mimeographed station list in the Zoological Museum, Copenhagen), – two samples, two species.
5. *The* "*Galathea*" *Expedition* 1950-52 (A. F. Bruun 1958: General Introduction to the Reports and List of Deep Sea Stations), – 21 samples, 13 species.

The additional samples listed above were included partly because they could serve to solve taxonomic problems and partly because they could yield information on anatomy and zoogeography. These samples are all from the Indian Ocean or the south-east Asian waters. A list of all the 44 species (12 represented by shells only) included in the present report is found on p. 244.

Short descriptions of the shells of all the species and measurements (length × height × breadth) in millimeters of the largest recorded shell are given in the taxonomic part of the report. In addition, some observations have been made on the anatomy of most of the species present. The stomach contents have been observed in several species, and special attention has been paid to reproductive features which could be observed in preserved material, viz., the sizes of the prodissoconch and of ripe eggs in the gonad (both given in μ), both indicating the type of larval development found in a species.

For each species, the geographical and bathymetrical distribution, together with the known temperature range is studied in some detail, with the view of contributing to the knowledge of the distribution of the bathyal and abyssal faunas and the factors determining these distributions. However, in the majority of the older literature on the subject, the authors did not distinguish between "live specimens" and "dead shells". Since "dead shells" could be subfossil or subjected to transport, such a distinction is important. In the present report such a distinction has been adhered to, united pairs of valves, and dry shells showing remnants of dried-up soft parts being included in the category of "live specimens". The present author has been fortunate enough to be able to re-examine many samples of deep-sea bivalves from earlier expeditions ("*Challenger*", "*Siboga*", "*Valdivia*", "*Travailleur & Talisman*", "*Campagnes Scientifique du Prince Ier de Monaco*") and in this way collect information as to whether a sample contained "live specimens" or single valves only. In this report, by using the older collections, the still unpublished material of the "*Galathea*" *Expedition* and the present material, the author has attempted to work out the horizontal and vertical distributions of as many species as possible, considering only the "live specimens" mentioned as such in the literature or material examined by the present author. In addition, the *in situ* temperature has been recorded for every sample containing "live specimens" and the temperature ranges worked out. Because many species have been recorded once or a few times only, the available information on both their distribution and temperature range is obviously insufficient, but it is the hope of the present author that future investigations will pay more attention to this aspect.

If no information on the bottom temperature of a certain sample is available, it has been attempted, as far as possible, to obtain the information wanted from the same depth at a nearby hydrographical station. To this end the following works have been consulted: Bruneau, Jerlov & Koczy 1953; Fuglister 1960; Japan Meteorological Agency 1959; Kiilerich 1964; van Riel 1956; Schott 1935; Thomsen 1937; "*Albatross*", the *Philippine Exped.* 1907-10. Station list; Wyrtki (1961).

All depth records given in fathoms have been re-calculated to meters(m) and all temperature records have been re-calculated to centigrades.

The text figures marked "P.H.W." have been executed by the late artist Poul H. Winther; the remaining ones by the author by means of a drawing apparatus. The photographs have been executed by Mr. H. V. Christensen.

All the samples from the "*John Murray*" *Expedition*, including the types, are in the British Museum (Nat. Hist.) London; all the remaining samples are in the Zoological Museum, Copenhagen.

In delimiting the Indian Ocean I have followed Sverdrup, Johnson & Fleming (1946). The Indian Ocean is separated from the Atlantic by the meridian of the Cape of Good Hope (20° E.); towards the east the border is put at a line from the Malay Peninsula-Sumatra-Java-Timor to N.W. Australia at Cape Londonderry (at about 127° E.), and from Tasmania (at 147° E.) southwards. The southern limit of the Indian Ocean is defined as the region of the subtropical convergence at about 40° S.

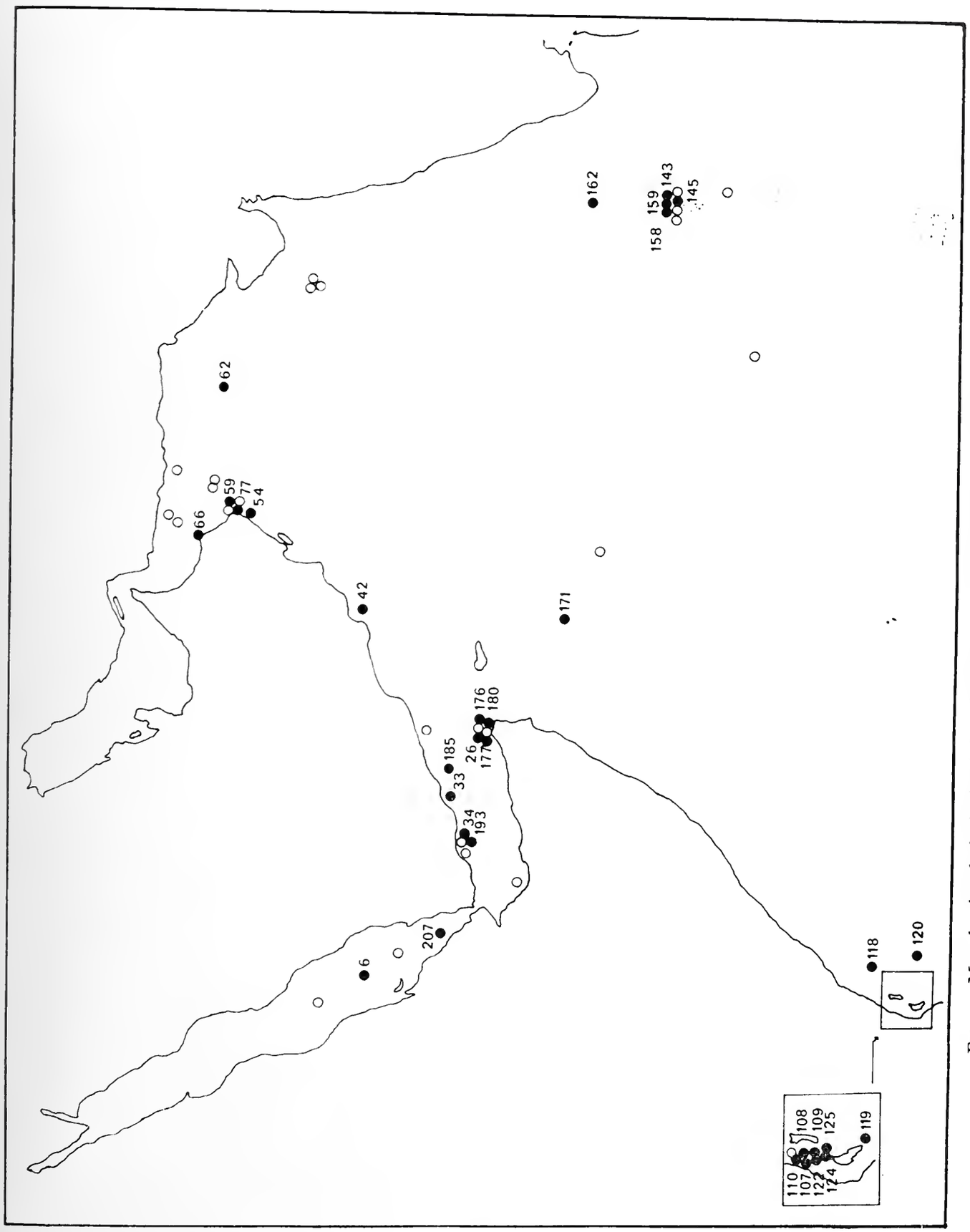


FIG. 1. Map showing the bathyal and abyssal stations of the "*John Murray*" *Expedition*. ● and St. no. indicates the stations at which bivalves were obtained. ○ indicates stations without bivalves.

Following the suggestion of Wyrtki (1961) the term south-east Asian Waters has been used for the sea extending (and including) the Philippine waters, the China Sea and the Indonesian waters as well as the Andaman Sea.

In defining the depth zones the terminology adopted by Bruun (1956, 1957) has been used. The bathyal zone covers the depth from about 400 m to some 2000 m and a temperature range between 4 and 10°C. (It should be mentioned, that according to the experience of the present author, the upper temperature limit should be put at about 12°C). The abyssal zone covers the sea bottom between 2000 and 6000 m with temperatures below 4°C. It should be pointed out, however, that the depth ranges given here are subject to considerable variation in different areas of the Ocean. The term "deep-sea", frequently used in the present paper, is meant to cover both zones.

ACKNOWLEDGEMENTS

I am greatly indebted to the Trustees of the British Museum (Natural History), (hereafter B.M. (N.H.)), for permission to borrow the material of deep-sea bivalves of the "*John Murray*" *Expedition*. I wish to thank Mr. N. Tebble and the staff of the Mollusca Section of the Zoology Department of the B.M. (N.H.) for kind help and hospitality during my visits in 1958 and 1962.

In October 1965 I was able to visit the mollusc departments of the Museum of Comparative Zoology, Harvard University, Massachusetts, and of the U.S. National Museum, Washington, D.C., with the purpose of studying their rich collections of deep-sea bivalves, and I am much indebted to the staff of these institutions for hospitality and help. For loan of material I thank the following: Mrs. W. S. S. van der Feen, Zoologisch Museum, Amsterdam, for loan of specimens from the "*Siboga*" *Expedition*; Dr. R. Kilias, Zoologisches Museum, Berlin, for loan of material from the "*Valdivia*" *Expedition*; Dr. O. Paget, Naturhistorisches Museum, Vienna, for the loan of a sample of *Cuspidaria alcocki* E. A. Smith and for attempting to locate the collection of the "*Pola*" *Expedition*. I am also grateful to Mr. G. Grau, Hollywood, California, U.S.A., for presenting identified specimens of *Amussium jeffreysi* E. A. Smith and *A. caducum* E. A. Smith to the Zoological Museum, Copenhagen.

I am deeply indebted to the late artist Mr. P. H. Winther for the skilful way in which he executed the drawings; Mr. H. V. Christensen, photographer, for the careful photography; Dr. K. W. Ockelmann for much useful advice regarding examination of prodissoconchs and eggs and interpretations of the results; Dr. T. Wolff for identification of the remnants of small crustaceans from bivalve stomachs; and Dr. and Mrs. M. Horikoshi for translating into English a number of papers written in Japanese; Dr. T. Okutani for making available temperature measurements from the "*Soyo-Maru*" *Expeditions* in the Sagami Bay region, Japan.

Finally the author wishes to thank the Rask-Oersted Foundation for grants to visit the institutions mentioned above.

LIST OF SPECIES

* Species not obtained by the "*John Murray*" *Expedition*.
() Species represented by shells only.

NUCULIDAE

Nucula bengalensis E. A. Smith
Nucula donaciformis E. A. Smith
Acila divaricata (Hinds)

NUCULANIDAE

Tindaria murrayi n. sp.
**Malletia angulata* Sowerby
Malletia conspicua E. A. Smith
Nuculana fumosa E. A. Smith
Spinula filatovae n. sp.

ARCIDAE

Acar asperula (Dall)

LIMOPSIDAE

Limopsis pelagica E. A. Smith
Limopsis sansibarica Thiele & Jaeckel

MYTILIDAE

Amygdalum politum (Verrill & Smith)

PECTINIDAE
**Propeamussium sibogai* (Dautzenberg & Bavay)
Amussium andamanicum E. A. Smith
Amussium caducum E. A. Smith
Amussium jeffreysii E. A. Smith
Amussium meridionale E. A. Smith
Amussium sewelli n. sp.
(*Amussium steindachneri* Sturany)
Amussium watsoni E. A. Smith
Pecten alcocki E. A. Smith

UNGULINIDAE
(*Cryptodon bisecta* (Conrad))

LUCINIDAE
(*Lucina bengalensis* (E. A. Smith))
(*Lucina inanis* (Prashad))

VENERIDAE
Pitar sewelli n. sp.
Venus juvenilis E. A. Smith

SEMELIDAE
Abra profundorum (E. A. Smith)

TELLINIDAE
(*Tellina coromandelica* Salisbury)
(*Tellina travancorica* E. A. Smith)

PHOLADIDAE
Xylophaga murrayi n. sp.

MYOCHAMIDAE
Myodora quadrata E. A. Smith

VERTICORDIDIAE
Lyonsiella murrayi n. sp.
(*Euciroa crassa* Thiele & Jaeckel)
Euciroa eburnea (Wood-Mason & Alcock)
**Euciroa rostrata* Thiele & Jaeckel

POROMYIDAE
Poromya eximia Pelseneer

CUSPIDARIIDAE
**(Cuspidaria alcocki* E. A. Smith)
Cuspidaria approximata E. A. Smith
(*Cuspidaria brachyrhynchus* Sturany)
**Cuspidaria caduca* E. A. Smith
Cuspidaria dubia Pelseneer
Cuspidaria kawamurai Kuroda
(*Cuspidaria macrorhynchus* E. A. Smith)
(*Cuspidaria steindachneri* Sturany)

SYSTEMATIC PART

Family **NUCULIDAE**

Nucula bengalensis E. A. Smith, 1895

Text fig. 2; pl. 1, fig. 1.

1895a *Nucula bengalensis* E. A. Smith p. 15, pl. 2, fig. 9.
1897 *Nucula bengalensis*, Alcock & Anderson pl. 1, fig. 4, 4a-c.
1907 *Nucula mirifica* Dall p. 170.
1926 *Nucula mirifica*, Dall p. 22, pl. 29, fig. 4, 10.
1933 *Nucula bengalensis*, Prashad p. 126, pl. 1, fig. 1.
1940 *Nucula bengalensis*, Winckworth p. 25.
1962 *Ennucula mirifica*, Okutani p. 5, pl. 1, fig. 2.

MATERIAL: "*John Murray*" *Expedition:* St. 108, Zanzibar area, 5°18′06″S., 39°24′12″E.; depth: 786 m; bottom: grey mud; bottom temperature: 7·9°C.; gear: Agassiz trawl. – 1 pair of united shells.
"*Galathea*" *Expedition:* St. 489, Bali Sea, 7°38′S., 116°08′E.; depth: 1165–1135 m; bottom: dark clay; gear: Sigsbee trawl, dredge. – 6 specimens, 1 pair of united shells and 3 single shells.

DESCRIPTION: The shell is thin and covered by a greenish brown periostracum. The umbo is low and rounded; the postero-dorsal edge slightly curved in lateral view. No distinct delimination of lunule or escutcheon. The prodissoconch is distinct and white and has a length of about 300 μ. In some specimens a very fine radial striation is present, with a fine irregular concentric, striation. The

ventral margin is smooth. The resilophore is well developed and projects towards the posterior edge. The number of hinge teeth varies as follows:

Total length	19	19	21	23
Preumbonal	8	8	8	8
Postumbonal	20	20	18	21
Total	28	28	26	29

Thus the total number of teeth in shells 19–23 mm long varies between 26 and 29. The adductor scars are distinct and rather large, the anterior rounded and the posterior triangular. The inner surface of the shell is smooth, but a fine radiating structure is visible.

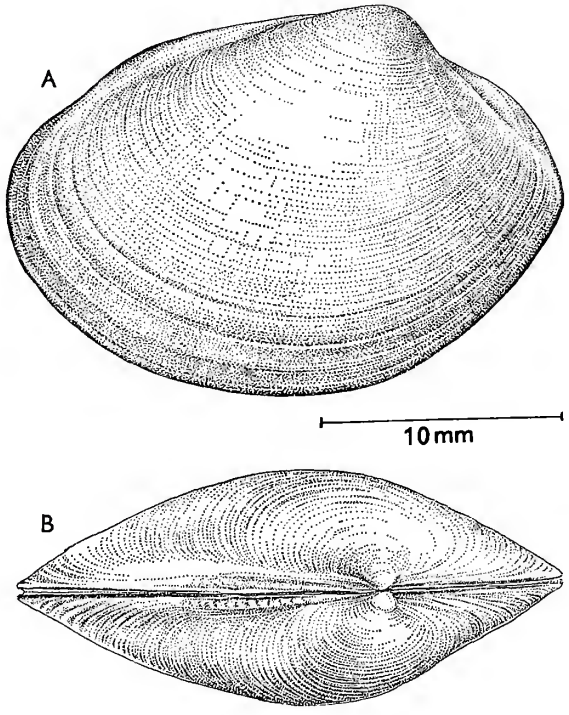


FIG. 2. *Nucula bengalensis* E. A. Smith; "*Galathea*" St. 489. (A) left valve, lateral view. (B) dorsal view of shell. P.H.W.

DIMENSIONS IN MM: A "*Galathea*" specimen: 22·4 × 15·1 × 9·6.

REPRODUCTION: One specimen contained apparently ripe eggs having diameters of about 200 μ.

REMARKS: The present material completely agrees with Smith's (1895a) description and figures and also with the good figure given by Prashad (1933). The shell figured by Alcock & Anderson (1897) is 17 mm long and has 7 + 18 = 25 hinge teeth. Dall (1907) described *N. mirifica* from the waters off Japan (Hokkaido); the species was figured by Dall (1926). By comparing Dall's description and figure with that of Smith and with the present material, it seems quite evident that Dall's *mirifica* is only a synonym of *N. bengalensis*. The two descriptions run almost parallel and the only difference in the figures given is that Smith's species has a slightly more arched postero-dorsal edge than Dall's species, but otherwise they seem to agree in all details. Dall states his species to be 36 mm long, and that the number of hinge teeth is 10–11 preumbonal and 16–17 postumbonal – a number differing somewhat from that observed in the present material.

DISTRIBUTION: Smith recorded *N. bengalensis* from "*Investigator*" St. 162, off the Coromandel coast, depth: 265–458 m, but does not mention whether he had live specimens or shells only at his disposal. Dall (1907) described *N. mirifica* from off N. Japan (Hokkaido) at a depth of 492 m, but again no live specimens are recorded. Prashad added another "*Investigator*" shell, from St. 280, Bay of Bengal, depth: 816 m. Okutani (1962) recorded live specimens from three localities in the Sagami Bay, S.E. Japan, at depths ranging from 1190–1400 m. The U.S.N.M., Washington, D.C., contains the following material of the species, seen by the present author: 1) One united pair of shells with the dry soft parts labelled "*Nucula bengalensis* Smith, Bay of Bengal, 145–250 fath." No other information is given on the label, but presumably the sample originates from the "*Investigator*" *Expedition* St. 162 – the only station of the expedition in the Bay of Bengal at that depth. 2) four samples from the "*Albatross*" *Pacific Expedition* 1906, labelled *Nucula mirifica* Dall and all containing specimens with dry soft parts. Three of these samples come from the region south of Hokkaido (St. 5039, 5040 (type locality) and 5045) at depths of 492 – 657 m, the fourth (St. 5053) from off the S.E. part of Honshu, depth: 920 m. Thus the horizontal distribution of the species extends from off E. Africa (Zanzibar area) to off N.E. Japan at depths ranging from 265–457 to 1400 m. The temperature range would seem to be from about 7·6°C. to about 10°C.

Nucula donaciformis E. A. Smith, 1895

Text fig. 3; pl. 1, fig. 2.

1895a *Nucula donaciformis* E. A. Smith p. 15, pl. 2, fig. 8.
1897 *Nucula donaciformis*, Alcock & Anderson pl. 1, fig. 5, 5a-c.
1932a *Nucula donaciformis*, Prashad p. 14.
1933 *Nucula donaciformis*, Prashad p. 128, pl. 1, fig. 4.
1940 *Nucula donaciformis*, Winckworth p. 25.

MATERIAL: "*John Murray*" *Expedition:* St. 62, northern area of Arabian Sea, 22°53′30″N., 64°56′10″E.; depth: 1893 m; bottom: grey clay; bottom temperature: 4·0°C.; gear: Agassiz trawl. – 1 specimen, 1 shell.

St. 185, Gulf of Aden, 13°48′06″N., 49°16′48″E.; depth: 2000 m; bottom: green mud; gear: Agassiz trawl. – 11 specimens.

St. 207, Red Sea, 14°08′56″N., 42°19′00″E.; depth: 375 m; bottom: green mud, pteropods; gear: modified Petersen grab. – 1 specimen, soft parts dried up.

"*Galathea*" *Expedition:* St. 302, Bay of Bengal, 19°42′N., 86°48′E.; depth: 1190 m; bottom: clay; gear: sledge trawl. – 20 shells.

St. 453, Makassar Strait, 3°56′S., 118°26′E., depth: 1989 m; bottom: greenish clay; bottom temperature: 3·6°C. – 2 specimens.

DESCRIPTION: The shell is rather solid, rounded-triangular in lateral view. The antero-dorsal edge is nearly straight, the postero-dorsal slightly curved. These two edges form an approximate right angle. The ventral edge is curved. The two live specimens present are covered with a brownish-green periostracum. The shell has a concentric sculpture consisting of somewhat irregular undulate ribs. In addition there is a fine radiating sculpture consisting of about 70 fine regularly spaced lines. The prodissoconch is about 220 μ long. The resilium is relatively small. The number of hinge teeth is as follows:

Total length	right		6*	10*	15		16	18*	19		22
	left	5				15				21	
Preumbonal		7	9	9	11	11	12	13	13	13	13
Postumbonal		11	13	16	23	22	13	23	27	27	27
Total		18	22	25	34	33	35	36	40	40	40

The shells marked * are from the "*Siboga*" *Expedition.*

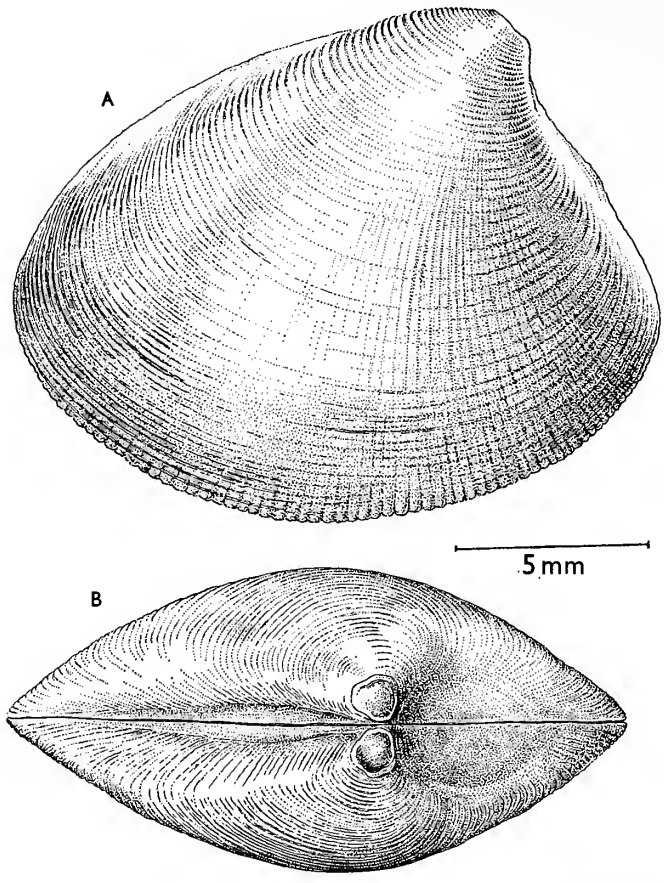


FIG. 3. *Nucula donaciformis* E. A. Smith; "*Galathea*" St. 453. (A) left valve, lateral view. (B) dorsal view. P.H.W.

It appears that the number of teeth varies from 18 in a shell of 5 mm length, to 40 in shells of 19–22 mm. The adductor scars are distinct; the anterior scar is rounded while the posterior is oblong. The interior of the ventral edge has a very distinct crenulation corresponding to the radiating sculpture, which is distinctly seen also on the inner surface of the shell.

DIMENSIONS IN MM: "*Galathea*" specimen: 19·1 × 14·7 × 9·4.

REMARKS: The material of the "*Galathea*" *Expedition* consists of large specimens which are easily identified from Smith's (1895a) description and figures. In addition the present collection has been compared with the samples from the "*Siboga*" *Expedition* and referred to *N. donaciformis* by Prashad (1932). The material of the "*John Murray*" *Expedition* consists exclusively of small specimens, 4–6 mm long. They are more rounded in shape than the larger shells from "*Galathea*" and "*Siboga*", which are from 15–22 mm long. The "*John Murray*" shells, however, do have the characteristic concentric sculpture found also in the "*Galathea*" specimens, and likewise, the radiating lines and the crenulation of the ventral edge is distinct in the "*John Murray*" specimens. The number of radiating lines and denticles of the marginal crenulation is about 70, as in the "*Galathea*" specimens.

DISTRIBUTION: Smith recorded *N. donaciformis* from "*Investigator*" St. 162, Bay of Bengal, depth: 265–458 m, without indicating whether live specimens or shells only were found. Prashad (1932) recorded the species from the following three "*Siboga*" stations, 27, 87, and 178 all in the S.E. Asian waters and at depths ranging from 210–835 m. By examining this collection the present author found that specimens having dried-up soft parts had been collected at all three stations listed above. Prashad (1933) recorded the species from an additional "*Investigator*" station, viz., 259, Laccadive Sea, depth: 540–658 m. Thus the horizontal distribution of the species extends from the Red Sea, throughout the northern part of the Indian Ocean to the S.E. Asian waters. The vertical distribution is from 210–2000 m and the temperature range from about 3 to 21–22°C.

Acila divaricata (Hinds, 1843)

Text fig. 4, 5; *pl.* 1, *fig.* 3.

1843 *Nucula divaricata* Hinds p. 97.
1850 *Nucula mirabilis* Adams & Reeve p. 75, pl. 21, fig. 8.
1871 *Nucula mirabilis*, Sowerby in : Reeve pl. 1, fig. 4.
1871 *Nucula divaricata*, Sowerby in: Reeve pl. 4, fig. 29.
1882 *Nucula mirabilis*, Dunker p. 238.
1885 *Nucula* (*Acila*) *mirabilis*, E. A. Smith p. 230.
1893 *Nucula* (*Acila*) *fultoni* E. A. Smith p. 111.
1897 *Nucula* (*Acila*) *fultoni*, Alcock & Anderson pl. 1, fig. 3, 3a-c.
1898 *Nucula divaricata*, Dall p. 572.
1902 *Nucula fultoni*, Alcock p. 282, fig. 80.
1904 *Nucula fultoni*, E. A. Smith p. 12.
1931 *Nucula jucunda* Thiele & Jaeckel p. 40, pl. 2, fig. 42.
1932a *Nucula mirabilis*, Prashad p. 17.
1933 *Nucula* (*Acila*) *fultoni*, Prashad p. 133, pl. 1, fig. 15.
1934 *Acila divaricata*, Schenck p. 41.
1934 *Acila fultoni* Schenck p. 42.
1935 *Nucula* (*Acila*) *divaricata*, Thiele p. 786.
1935 *Acila* (*Acila*) *divaricata*, Schenck p. 3.
1935 *Acila* (*Acila*) *fultoni*, Schenck p. 4.
1936 *Acila* (*Acila*) *fultoni*, Schenck p. 102, fig. 8, pl. 16, fig. 1-9.
1937 *Acila* (*Acila*) *fultoni*, Heath p. 4, pl. 5, fig. 38, 40, 45; pl. 9, fig. 82.
1940 *Nucula* (*Acila*) *fultoni*, Winckworth p. 25.
1958a *Acila divaricata*, Habe p. 243, pl. 12, fig. 7.
1958a *Acila schencki* Kuroda in: Habe p. 243.
1959 *Acila divaricata*, Kira p. 107, pl. 41, fig. 5.
1959 *Acila schencki*, Kira p. 107, pl. 41, fig. 6.
1959 *Acila divaricata vigilia* Kira p. 107, pl. 41, fig. 7.
1962 *Acila* sp., Okutani p. 3, pl. 1, fig. 1.
1962 *Acila divaricata*, Kira p. 119, pl. 42, fig. 5.
1962 *Acila schencki*, Kira p. 119, pl. 42, fig. 6.
1962 *Acila divaricata vigilia*, Kira p. 119, pl. 42, fig. 7.

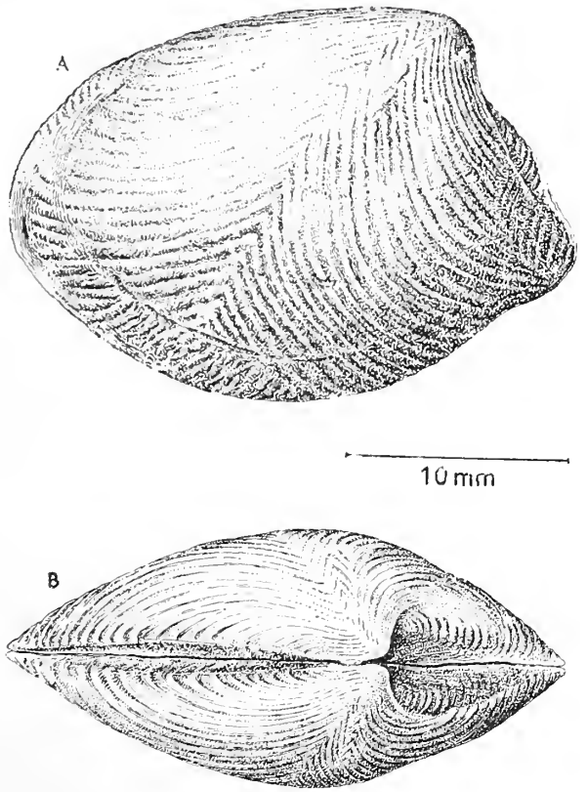


FIG. 4. *Acila divaricata* (Hinds); "*Galathea*" St. 489. (A) left valve, lateral view. (B) dorsal view. P.H.W.

MATERIAL: *"Investigator" Expedition:* St. III, Bay of Bengal, 20°49′N., 89°08′E.; depth: 748 m; bottom: green ooze, pteropods; bottom temperature: 8·3°C. – 2 specimens.

"John Murray" Expedition: St. 54, South Arabian coast, 21°50′N., 59°52′E.; depth: 1046 m; bottom: green mud; bottom temperature: (at 900 m): 9·6°C; gear: Agassiz trawl. – 215 specimens. St. 108, Zanzibar area, 5°18′06″S., 39°24′12″E.; depth: 786 m; bottom: grey mud; bottom temperature: 7·9°C; gear: Agassiz trawl. – 2 shells.

"Galathea" Expedition: St. 489, Bali Sea, 7°38′S., 116°08′E.; depth: 1165–1135 m; bottom: dark clay; gear: Sigsbee trawl, dredge. – 5 specimens, 7 shells.

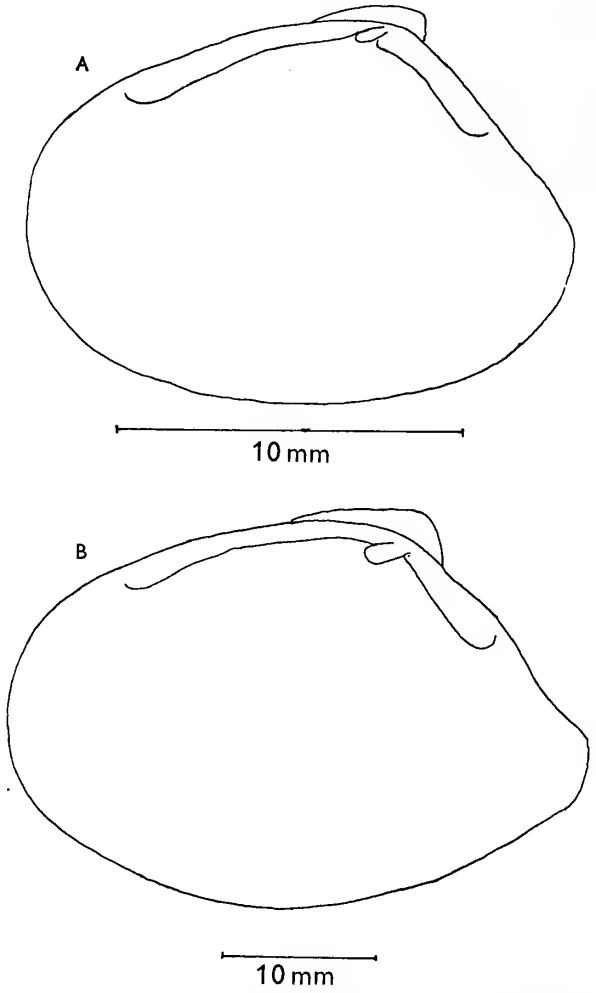


FIG. 5. *Acila divaricata* (Hinds); interior of shells. (A) *"John Murray"* St. 54, 15·8 mm long. (B) *"Investigator"* St. III, 38 mm long.

DESCRIPTION: The shell is thick with a brown periostracum. In lateral view the antero-dorsal edge is slightly convex, while the postero-dorsal edge is nearly straight. In smaller specimens the shell is oval in outline, while in larger specimens a posterior projection has developed. The lunule is distinct and narrow, the escutcheon is broad. The whole shell is provided with a regular and distinct divaricate sculpture, consisting of ribs separated by interstices having approximately the same breadth as the ribs. In addition, concentric growth lines are increasingly distinct towards the ventral margin. The ventral edge is irregularly crenulate, reflecting the sculpture. The prodissoconch is smooth and has a length of about 230 μ. As is seen in the following table, the number of hinge teeth is subject to variation in relation to the size of the specimen.

Length	2[1]	14	14	16	16	17	17	17	18[1]	19	21	22
Preumbonal	7	16	17	18	17	19	18	17	21	18	19	17
Postumbonal	4	8	8	9	9	10	9	8	10	9	11	10
Total	11	24	25	27	26	29	27	25	31	27	30	27
Length	24	24	24	24	24	27	28	29[2]	35[2]	35		
Preumbonal	22	19	19	20	18	22	19	21	23	23		
Postumbonal	11	9	10	10	9	12	11	10	12	12		
Total	33	28	29	30	27	34	30	31	35	35		

The shells marked [1] are from "*Valdivia*" St. 245, the shells marked [2] are from "*Investigator*" St. III, while the remaining shells all come from "*John Murray*" *Expedition* St. 54. It is seen that the number of teeth varies between 11 in a 2 mm long shell to 35 in 35 mm long shells.

Reproduction: Mature eggs were found in several females, the smallest of which was 16 mm long. The eggs had diameters of 150–160 μ.

Remarks: *Nucula divaricata* and *mirabilis* were both described from Japanese waters, and should be synonymized, a view held for instance by Habe 1958a. Okutani (1962) did not assign a specific name to his material. His figure shows, however, that it belongs to *A. divaricata*. Okutani correctly included *A. schencki* in his species. The present author has had the opportunity of examining some 20 samples all named *A. mirabilis* in the U.S.N.M., Washington, D.C. All the samples come from the Japanese waters and were collected by the "*Albatross*" *Expeditions*. In addition the collection of the Zoological Museum, Copenhagen contains two very well preserved shells from Sagami Sea, Japan collected by Dr. Th. Mortensen. These samples were compared to the samples listed above from the Indian Ocean and the S.E. Asian waters with the results that they are certainly conspecific, so that *A. fultoni* should be considered a synonym of *A. divaricata*. It is of interest to note that this view was held also by Dall (1898).

Thiele & Jaeckel (1931) described *N. jucunda* from "*Valdivia*" St. 245, Zanzibar area, 463 m depth. The material consisting of 5 shells (the smallest one with dry soft parts) and some fragments has been examined by the present author. It was found, that *N. jucunda* most likely should be considered a synonym of *A. divaricata*.

Distribution: The samples examined by the present author in the U.S.N.M. show, that *A. divaricata* is widely distributed in the Japanese Sea as far as about 45° N. as well as off Korea at depths ranging from about 18–350 m. It has been found off the coast S. of Hokkaido (about 42°N.) at about 315 m depth. On the Pacific side the species has been recorded from off Honshu at about 38°N. and further south along the coast to the southwestern tip of Japan at depths ranging from 85–780 m. All the records listed above are of specimens alive on capture.

Smith (1893) recorded *A. fultoni* from "*Investigator*" St. 259, Laccadive Sea at depths ranging from 539–659 m, but gave no indication of the presence of live specimens. Thiele & Jaeckel recorded *N. jucunda* from the Zanzibar area at 463 m depth (one specimen with soft parts). Prashad (1932a) mentioned additional "*Investigator*" material from St. 162, Bay of Bengal at depths of 265–458 m, but no mention is made of live specimens. Heath (1937) had material from the Bay of Bengal at depths of 366–549 m ("*Investigator*"?).

The horizontal distribution of *A. divaricata* thus extends from the waters of N. Japan to off E. Africa. The vertical distribution extends from about 18–1046 m. It appears, however, that in the northern part of its area of distribution it is found in more shallow water than further south. The temperature range would seem to be from about 2·8°C to somewhat over 20°C.

Family **NUCULANIDAE**

Tindaria murrayi n. sp.

Text fig. 6; *pl.* 1, *figs.* 6, 7.

MATERIAL: *"John Murray" Expedition:* St. 26, Gulf of Aden, 12°29′30″N., 50°51′30″E.; depth: 2312 m; bottom: soft grey white mud; bottom temperature: 2·7°C; gear: Agassiz trawl. – 1 specimen.

DIAGNOSIS: A *Tindaria* on which the postumbonal part of the shell forms about 56% of the total length of the shell and the amphidetic ligament about 28%. The proportion of anterior denticles compared to posterior denticles is about 1·75. The anterior muscular impression is about double the size of the posterior one and no pallial sinus is present.

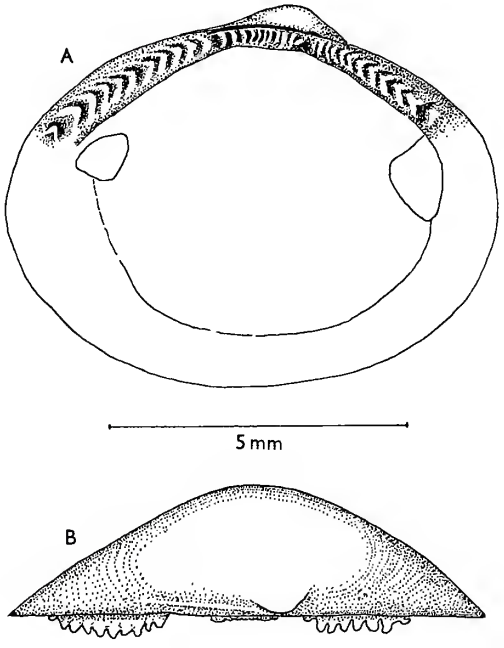


FIG. 6. *Tindaria murrayi* n. sp., type; *"John Murray"* St. 26. (A) interior of left valve. (B) dorsal view of left valve.

DESCRIPTION: The shell is oval and somewhat inequilateral with a relatively small umbo; the postumbonal part of the shell forming about 56%. The colour is light brown. There is a well-developed concentric sculpture consisting of regularly spaced rounded ribs, the interstices being about the breadth of a rib. The concentric sculpture gradually becomes more distinct towards the periphery. A faint rounded ridge runs from the posterior part of the umbo, petering out a little more than half the distance to the posterior end of the shell. The prodissoconch is rather indistinct but seems to have a length of about 185 μ. The ligament is completely external, amphidetic, and forms about 28% of the total length of the shell. The right valve has 12 anterior and 21 posterior denticles, the left valve has 12 and 22 respectively. The anterior and posterior rows of denticles are separated by a very narrow edentulous space. The interior surface of the shell is shiny, and the adductor scars and the mantle impression are indistinct. The adductor scars are rounded-triangular in outline, the anterior being about double the size of the posterior. The pallial impression does not show a posterior sinus, the posterior part being flattened out to form almost a straight line.

DIMENSIONS IN MM: Total length: 8·0; height: 6·2; breadth: 4·4; postumbonal length: 4·5; ligament length: 2·2; preumbonal hinge length: 2·5; postumbonal hinge length: 4·3.

Relationship: The present species would seem to be closely related to *T. perrieri* Dautzenberg & Fischer (1897), which was obtained in the Azores at a depth of 1846 m and also recorded by Locard (1898) from off Morocco at a depth of 2190 m. The species was figured by Dautzenberg & Fischer (1897), Locard (1898) and Dautzenberg (1927). *T. perrieri*, however, differs from *T. murrayi* in having a more anterior umbo, the postumbonal part of the shell forming about 62% of its total length. In the two known shells of *T. perrieri* (8 and 9 mm long respectively) the number of preumbonal and postumbonal hinge teeth were 9 and 10, and 22 and 25 respectively. This gives the proportion of preumbonal hinge teeth compared to postumbonal teeth as 2·5, while in *T. murrayi* the corresponding proportion is 1·75.

Thiele & Jaeckel (1931) described *T. antarctica* from the Antarctic Ocean at a depth of 4636 m. This species has a regular concentric sculpture. The umbo is more anterior than in *T. murrayi*, the postumbonal part of the shell forming about 62% of the shell, and in addition, the postero-dorsal edge of the shell is nearly straight. Clarke (1959) described *T. erebus* from a single specimen, 7·4 mm long taken off Bermuda at a depth of 5202 m. In shape and sculpture it is very close to *T. murrayi*. It seems to differ in certain hinge characters; e.g. the preumbonal and postumbonal teeth are separated by a much wider space than in *T. murrayi* and also the number of teeth differs: ten anterior and 13 posterior in *T. erebus*. In addition, it seems that the anterior adductor scar is much larger in *T. murrayi* than in *T. erebus*. Clarke (1961) described *T. championi* from the S. Atlantic, depth: 5133 m. This species, too, is similar to *T. murrayi* both in shape and sculpture. The ligament in *T. championi* is, however, much shorter than in *T. murrayi*, forming only 18% of the total length of the shell. The hinge plate in *T. championi* is bent, the two parts forming an angle of about 120°, while in *T. murrayi* it is evenly curved. The number of hinge teeth in *T. championi* is seven anterior and nine posterior (total length of the shell: 5·8 mm); this gives a proportion of about 1·3 for anterior to posterior teeth. Finally, *T. championi* shows a faint pallial sinus.

Barnard (1963) recorded and figured a single shell referred to as *Sarepta* sp. In shape and sculpture it is very similar to the present species. It differs, however, by having only ten posterior hinge teeth. Barnard's shell has a total length of 5 mm and was dredged off S. Africa, depth: 2743–3219 m. The present species has been named for Sir John Murray.

Type: B.M.(N.H.) Reg. No. 1966451.

Malletia angulata Sowerby, 1888
Text fig. 7A; pl. 1, figs. 4, 5.

1888 *Malletia angulata* Sowerby p. 208, pl. 11, fig. 15.
1897 *Yoldia angulata*, Alcock & Anderson pl. 2, fig. 6, 6a-c.
1940 *Yoldia angulata*, Winckworth p. 26.

Material: "*Investigator*" *Expedition:* St. 1, off Ganges Delta, Bay of Bengal, 21°6′30″N., 89°20′E.; depth: 521–741 m; bottom: green mud, pteropod ooze; gear: Blake trawl. – 2 specimens.
The material is in the Zoological Museum, Copenhagen.

Description: The shell is thick and opaque with a dark brown periostracum. The postumbonal part forms about two thirds of the length of the shell. In lateral view the umbo is rather prominent, the dorsal edge nearly straight. The posterior part of the shell forms a characteristic beak; the postero-dorsal part is laterally constricted and the constriction is bound by a distinct rounded edge, which peters out towards the posterior end of the shell. The shell has a very distinct irregular concentric foliated sculpture, and a fine concentric striation. No radiating sculpture was observed. The ligament

is completely external, extending from the umbo posteriorly along the whole length of the straight part of the dorsal edge. The number of hinge teeth is as follows:

Total length	23		27	
	right	left	right	left
Preumbonal	11	10	11	11
Postumbonal	39	39	36	38
Total	50	49	47	49

The preumbonal teeth are larger than the postumbonal teeth which extend almost to the posterior end of the ligament. The prodissoconch was not seen. The adductor scars are indistinct; the anterior almost circular and rather large, the posterior smaller and oblong. In one of the specimens the left valve has a prominent crest along the antero-ventral margin of the anterior muscle scar, but this is not visible in the three other shells. The pallial sinus is broad. *The soft parts:* the mantle edges are completely separate, the posterior part has a well-developed fold, shaped as two valves. The smaller dorsal one is situated ventral to the posterior adductor. The larger ventral valve has 15–20 slender tentacles along the posterior edge. A long slender tentacle is present on the right side posterior of the valve.

Dimensions in mm: Present specimen: 23·0 × 12·7 × 9·0.

Remarks: The present sample has a label which gives the specific name, probably in the handwriting of Sowerby or Smith. In addition, the specimens agree completely with the figures of the species.

Distribution: Sowerby (1888) did not mention where his material was acquired but merely marked it "Bay of Bengal, 200 fathoms". Prior to 1888 the only station of the "*Investigator*" run at that depth in that region would be St. I, the exact locality of which is: off False Point, 20°17′30″N., 88°50′E.; depth: 370 m. There is nothing to indicate whether live specimens were obtained, and the present specimens would seem to be the only live ones known. Thus the species is so far only known from the Bay of Bengal.

Malletia conspicua E. A. Smith, 1895
Text fig. 7 B, C.

1895a *Malletia conspicua* E. A. Smith p. 17, pl. 2, fig. 12.
1897 *Malletia conspicua*, Alcock & Anderson pl. 2, fig. 7, 7a-b.
1932a *Malletia conspicua*, Prashad p. 25.
1940 *Malletia conspicua*, Winckworth p. 25.

Material: "*Galathea*" *Expedition:* St. 489, Bali Sea, 7°38′S., 116°08′E.; depth: 1165–1135 m; bottom: dark clay; gear: Sigsbee trawl. – 2 specimens.

Six somewhat damaged shells are found in the collection of the "*John Murray*" *Expedition*, but unfortunately, the text of the label has disappeared.

Description: The shell is rather thin and covered with a light brown periostracum. The umbo is small, and the postumbonal part forms about two thirds of the shell. The postero-dorsal edge is nearly straight, except the distal end which is slightly curved dorsally. This curvature is more distinctly developed in the larger shells. A narrow area is separated by a sharp edge running from the umbo to the postero-dorsal angle. This area is subdivided by a fine, distinct longitudinal ridge. A faint line runs from the umbo to the antero-ventral edge of the shell. The prodissoconch (visible only in a single "*Siboga*" specimen) has a length of about 400 μ. The ligament is external and very prominent; its length is 20–25% of the total length of the shell. The distinct concentric sculpture consists of fine and fairly regularly spaced ridges, which gradually become less distinct towards the posterior end.

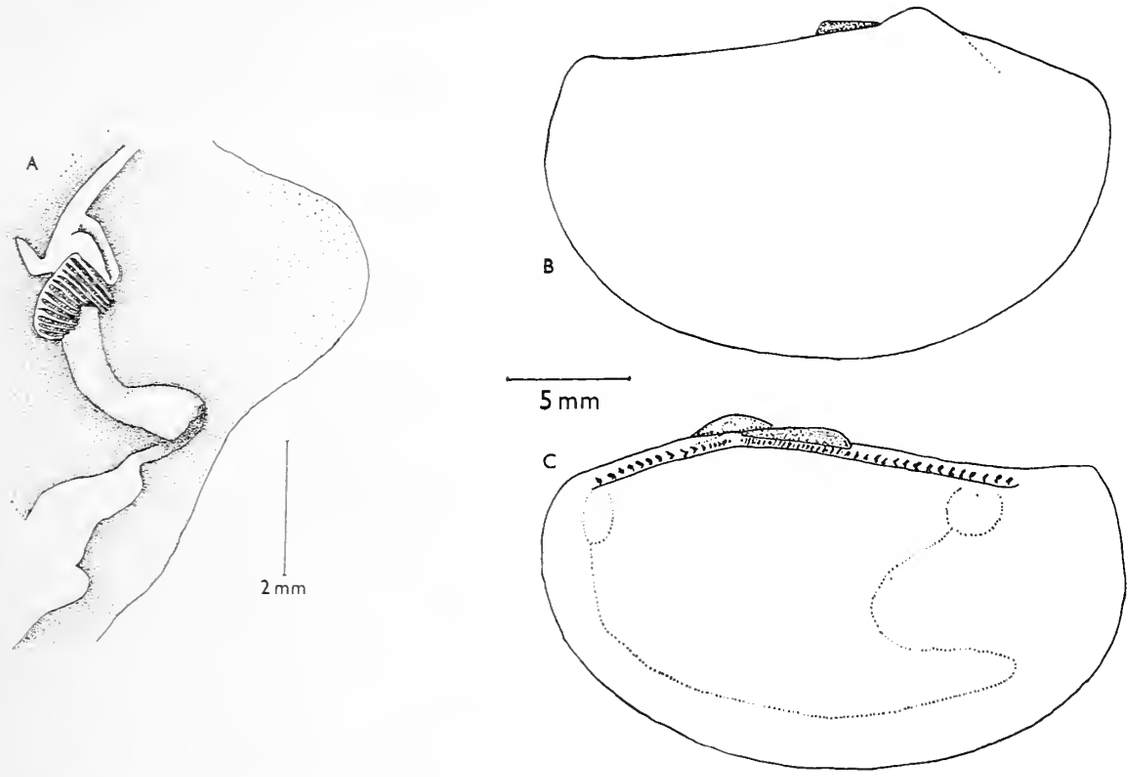


FIG. 7. (A) *Malletia angulata* Sowerby; "*Investigator*" St. 1. Right posterior mantle valve. (B, C) *Malletia conspicua* E. A. Smith; "*Galathea*" St. 489. (B) right valve, external view. (C) right valve, internal view.

The number of hinge teeth is as follows:

Total length	14	14	21	24	28
Preumbonal	14	14	19	18	17
Postumbonal	24	25	36	35	37
Total	38	39	55	53	54

From the above it will be seen that the total number of hinge teeth may vary from about 38 in shells of 14 mm length, to 53–55 in shells 21–28 mm long. The adductor scars are small and very indistinct; the anterior one elongate, the posterior rounded. The pallial sinus is broad and rather deep. *The soft parts:* the inhalant and exhalant openings are united to form a long and slender siphon which has a long, slender tentacle on the right side of the base. A well-developed fold runs ventrally from the siphon and continues to the anterior adductor; ventral to the latter a thickened pad is inserted between the fold and the mantle edge. The foot is very large with an expanded sole.

DIMENSIONS IN MM: "*Galathea*" specimen: 24 × 14·5 × 7·6.

REMARKS: The present material was found to agree very well with the fine figure given by Alcock & Anderson (1897), and also with the specimens from the "*Siboga*" material, which has been examined by the present author.

DISTRIBUTION: Smith described the species from "*Investigator*" St. 177, Arabian Sea, depth: 1163 m, but did not mention whether any live specimens were obtained. Prashad (1932a) recorded the species from the following "*Siboga*" stations: 48, 52, 300 and 314, all in the S.E. Asian waters. The present author has examined this material and found that specimens with dried-up soft parts were present at St. 52 and 300 at depths of 918–959 m. The known horizontal distribution thus comprises the N. Indian Ocean and the S.E. Asian waters. The vertical range would be from 918–1165 m, and the temperature range from 4·2–5·2°C.

Nuculana fumosa E. A. Smith, 1895
Pl. 1, *figs.* 8, 9.

1895a *Nuculana fumosa* E. A. Smith p. 16, pl. 2, fig. 10, 10a.
1895a *Nuculana indica* E. A. Smith p. 16, pl. 2, fig. 11, 11a.
1897 *Nuculana fumosa*, Alcock & Anderson pl. 1, fig. 2, 2a-c.
1897 *Nuculana indica*, Alcock & Anderson pl. 1, fig. 1, 1a-c.
1940 *Nuculana indica*, Winckworth p. 25.
1940 *Nuculana fumosa*, Winckworth p. 25.

MATERIAL: "*John Murray*" *Expedition:* St. 176, Gulf of Aden, 12°04′06″N., 50°38′36″E.; depth: 655–732 m; bottom: green mud, sand; gear: Agassiz trawl. – 1 specimen (soft parts dried up), 3 shells.

St. 180, Gulf of Aden, 12°03′24″N., 50°40′12″E.; depth: 397 m; bottom: green mud, sand; gear: modified Petersen grab. – 3 shells.

DESCRIPTION: The shell is thick, shiny and semi-transparent. The periostracum is brown. The postumbonal part forms about 60% of the total length of the shell. The umbo is prominent, the postero-dorsal edge is nearly straight, the posterior end pointed. The lunule is hardly recognizable, while the area is rather distinct, being delimited by means of a rounded edge running from the umbo towards the posterior end of the shell, but becoming obsolete some distance from the latter. Another, much more distinct rounded edge runs from the umbo to the posterior end of the shell some distance from the area. The postero-dorsal part of the shell, dorsal to the last-mentioned ridge, forms a flat area. The sculpture consists of an irregular, concentric striation. The prodissoconch has a length of 580–660 μ. The ligament is internal and triangular, and the ligament pit is small and triangular. The number of hinge teeth is as follows:

Total length	4·9	5·1	5·3	5·9	6·8	6·8
Preumbonal	12	13	12	14	13	14
Postumbonal	14	16	16	17	17	17
Total	26	29	28	31	30	31

The interior of the shell is glossy. The adductor scars and mantle impression are very indistinct; the anterior adductor scar is rounded, the posterior elongate and somewhat smaller. A broad and shallow pallial sinus may be observed.

DIMENSIONS IN MM: The specimen from St. 176 measured: 7·1 × 4·4 × 3·6.

REMARKS: Smith (1895a) described the two species *N. fumosa* and *N. indica* from the same locality ("*Investigator*" St. 162). The figures of the two species show that they are very much alike in general shape, and from the descriptions they also appear rather similar. Smith states *N. fumosa* to be 7 mm long, having 14 preumbonal and 17 postumbonal hinge teeth. This is very close to the number found in the present material in specimens of approximately the same size. *N. indica* is stated to be 12 mm long with 18 preumbonal and 20 postumbonal hinge teeth. The larger number of hinge teeth is in good accordance with the larger size of the specimen on which Smith founded his species. In view of the similarity, the author thinks it justified to synonymize the two species under the name of *N. fumosa*.

DISTRIBUTION: Smith (l. c.) recorded the species from "*Investigator*" St. 162, Bay of Bengal, at a depth of 265–457 m. The present material extends its area of distribution to include also the Gulf of Aden. Smith's figure 10a shows two united shells, and a live specimen was obtained at "*John Murray*" St. 176. The U.S.N.M., Washington, D.C. has a united pair of shells labelled "Bay of Bengal, St. 162" – obviously from the "*Investigator*" *Expedition*. The known vertical range of the species would seem to be from 265–457 m to 655–732 m. The temperature range appears to be from about 10–12°C.

Spinula filatovae n. sp.
Text fig. 8.

MATERIAL: *"John Murray" Expedition:* St. 26, Gulf of Aden, 12°29′30″N., 50°51′30″E.; depth: 2312 m; bottom: soft grey white mud; bottom temperature: 2·7°C; gear: Agassiz trawl. – 1 specimen.

DIAGNOSIS: A *Spinula* with a short pointed posterior projection, a regular concentric sculpture and a siphonal tentacle located on the left side of the siphon.

DESCRIPTION: The shell is equilateral, thick, whitish and covered with a thin light-brown periostracum. The umbo is rather prominent. In lateral view both the antero-dorsal and the postero-dorsal edges are straight. The two edges form an angle of about 145°. The posterior projection is short and pointed and is delimited from the ventral edge by a slight sinuosity. Lunule and area are narrow and delimited by faint ridges. The ligament is external and amphidetic and forms about 31% of the total length of the shell. The resilium is very small. A faint rounded ridge runs from the umbonal region to the extreme end of the posterior projection. Except for the umbonal region, the whole shell is provided with concentric ribs which are close set near the umbo but gradually become more distant and sharp towards the periphery. At the postero-dorsal edge the ribs are bent at right angles and continue to the dorsal edge. The interior of the shell is glossy. The prodissoconch is eroded. The hinge has 10 preumbonal and 11 postumbonal hinge teeth. The anterior adductor scar is small and almost circular; the posterior adductor scar is elongate. The pallial impression shows a broad, shallow, posterior sinus. *Soft parts:* could not be studied in detail. A well-developed retractile siphon is present and a single vermiform tentacle is present on the left side of the siphon. The intestine can be observed on the right side of the animal, and shows six coils.

DIMENSIONS IN MM: 4·8 × 3·0 × 1·75; length of ligament: 1·52.

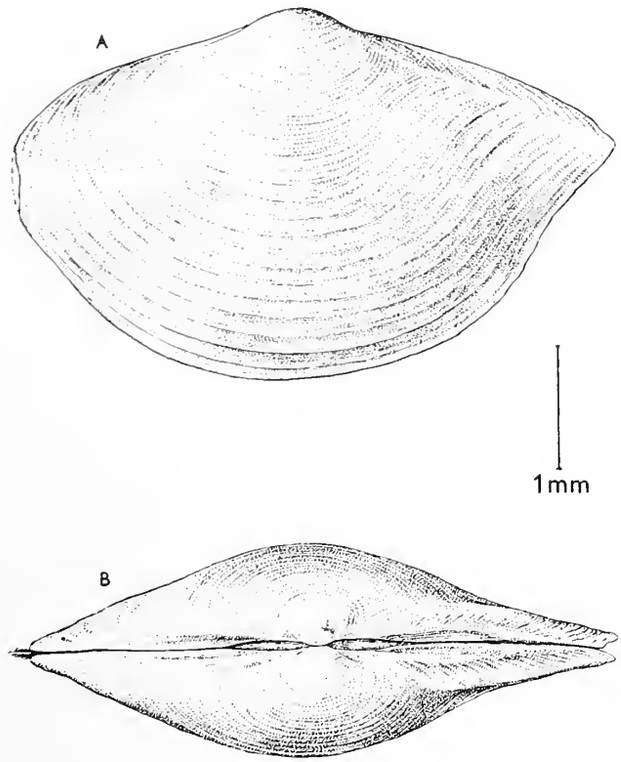


FIG. 8. *Spinula filatovae* n. sp., type; *"John Murray"* St. 26. (A) left valve, lateral view. (B) dorsal view. P.H.W.

RELATIONSHIP: The present species differs from *S. calcar* Dall (1908) in having a shorter posterior projection, a more developed concentric sculpture and a less distinct sinus ventral of the posterior projection. *S. calcarella* Dall has never been figured, and from Dall's brief description (l. c.) it is impossible to obtain an impression of the species. *Spinula calcar* is known from "*Albatross*" St. 4658, off the coast of Peru at a depth of 4337 m, and from five localities in the N.W. Pacific at depths ranging around 5500 m (Filatova, 1958). *S. calcarella* is known only from the type locality: "*Albatross*" St. 4656, off the coast of Peru at a depth of 4066 m, and it seems there are no subsequent records of the species. Thiele & Jaeckel (1931) described *Leda sinuata* from "*Valdiva*" St. 245, off E. Africa, depth: 463 m, and noted that the species should be referred to Dall's "group" *Spinula*. *S. sinuata* has a concentric sculpture similar to that of *S. filatovae*. It is, however, distinguished by the less prominent umbo, the different shape of the posterior projection and the presence of a deep sinus separating the posterior projection from the ventral edge. In *S. filatovae* the concentric sculpture extends to the dorsal edge, while in *S. sinuata* it extends only to the postero-dorsal ridge. Filatova (l. c.) described *S. oceanica* and *S. bogorovi*, both from abyssal depths of the N.W. Pacific ("*Vityaz*" *Expedition*). In *S. oceanica* the umbo is less prominent and the shell is without a pronounced concentric sculpture. In addition, the shape of the posterior projection and the sinus ventral to it differ markedly in the two species, and the soft parts show differences. In *S. oceanica* the siphonal tentacle is located on the right side, while in *S. filatovae* it is located on the left. Further, in *S. oceanica* the intestine forms nine coils, while in *S. filatovae* only six are present. *S. bogorovi*, which is known from shells only, differs from *S. filatovae* in having a strongly convex antero-dorsal edge and a very distinct, blunt posterior projection. In addition, the sinus is much more marked in *S. bogorovi* than in *S. filatovae*. *Spinula* (*Bathyspinula*) *vityazi* Filatova (1964) differs from *S. filatovae* by having a blunt projection without a sharp ridge and no sharp concentric sculpture. *S. vityazi* is known only from the Kurile-Kamsjatka and the Japan trenches at depths of more than 6000 m.

The present species has been named for my colleague Mrs. Z. A. Filatova.

TYPE: B.M.(N.H.) Reg. No. 196640W.

Family **ARCIDAE**

Acar asperula (Dall, 1881)

Text figs. 9, 10, 11, 12.

1881 *Macrodon asperula* Dall p. 120.
1885 *Arca profundicola* Verrill & Smith in: Verrill p. 439, pl. 44, fig. 23.
1885 *Arca* (*Barbatia*) *pteroessa* E. A. Smith p. 262, pl. 17, fig. 4.
1886 *Macrodon asperula*, Dall p. 244, pl. 8, fig. 4, 4a.
1889 *Macrodon asperula*, Dall p. 42, pl. 8, fig. 4, 4a.
1889 *Macrodon profundicola*, Dall p. 42, pl. 46, fig. 23, 23a.
1889 *Arca* (*Barbatia*) *pteroessa*, Dautzenberg p. 78.
1891 *Arca* conf. *pteroessa*, Wood-Mason & Alcock p. 446
1891 *Arca* (*Bathyarca*) *profundicola*, Kobelt p. 215, pl. 49, fig. 11.
1897 *Arca* (*Bathyarca*) *profundicola*, Dautzenberg & Fischer p. 201.
1898 *Bathyarca profundicola*, Verrill & Bush p. 844, pl. 78, fig. 2.
1904 *Arca pteroessa*, E. A. Smith p. 12.
1906 *Arca pteroessa*, E. A. Smith p. 253.
1908 *Arca* (*Cucullaria*) *endemica* Dall p. 399, pl. 17, fig. 8.
1920 *Arca profundicola*, Grieg p. 7.
1927 *Arca* (*Bathyarca*) *profundicola*, Dautzenberg p. 282.
1931 *Arca* (*Acar*) *profundicola*, Thiele & Jaeckel p. 20.
1932a *Arca incerta* (pars) Prashad p. 52.
1935 *Acar* (*Bentharca*) *asperula*, Thiele p. 793.

1962 *Bentharca pteroessa*, Okutani p. 13, pl. 1, fig. 12.
1962 *Bathyarca profundicola*, Clarke p. 56.
1962 *Bathyarca pteroessa*, Clarke p. 56.
1962 *Bathyarca asperula*, Clarke p. 56.
1962 *Cucullaria endemica*, Clarke p. 56.
1966 *Bathyarca profundicola*, Soot-Ryen p. 6, fig. 4.

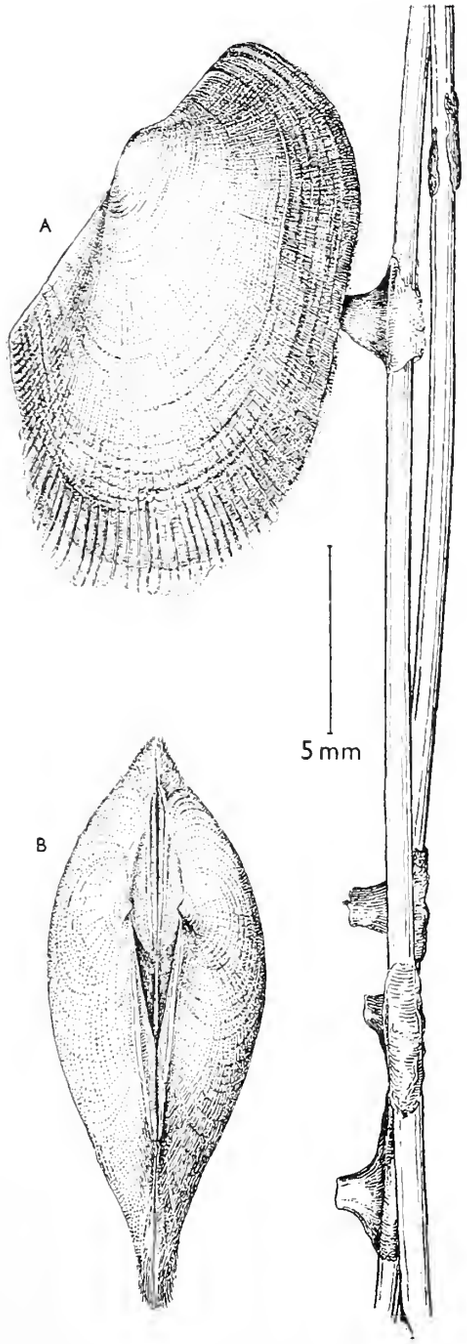


FIG. 9. *Acar asperula* (Dall); "*John Murray*" St. 26. (A) right side view of specimen fixed to the spicules of a siliceous sponge. Remnants of byssus of detached specimens are seen on the spicules. (B) dorsal view. P.H.W.

MATERIAL: "*John Murray*" *Expedition:* St. 26, Gulf of Aden, 12°29′30″N., 50°51′30″E.; depth: 2312 m; bottom: soft grey white mud; bottom temperature: 2·7°C, gear: Agassiz trawl. – About 110 specimens.

St. 108, Zanzibar area, 5°18′06″S., 39°24′12″E.; depth: 786 m; bottom: grey mud; bottom temperature: 7·9°C; gear: Agassiz trawl. – 1 specimen.

Th. Mortensen leg.: St. 29, Banda Sea, 5°38′S., 132°53′30″E.; depth: 430 m; bottom: mud; gear: trawl. – 1 specimen.

In addition to the material listed above the extensive material collected from the "*Galathea*" *Expedition* has been included in the present study.

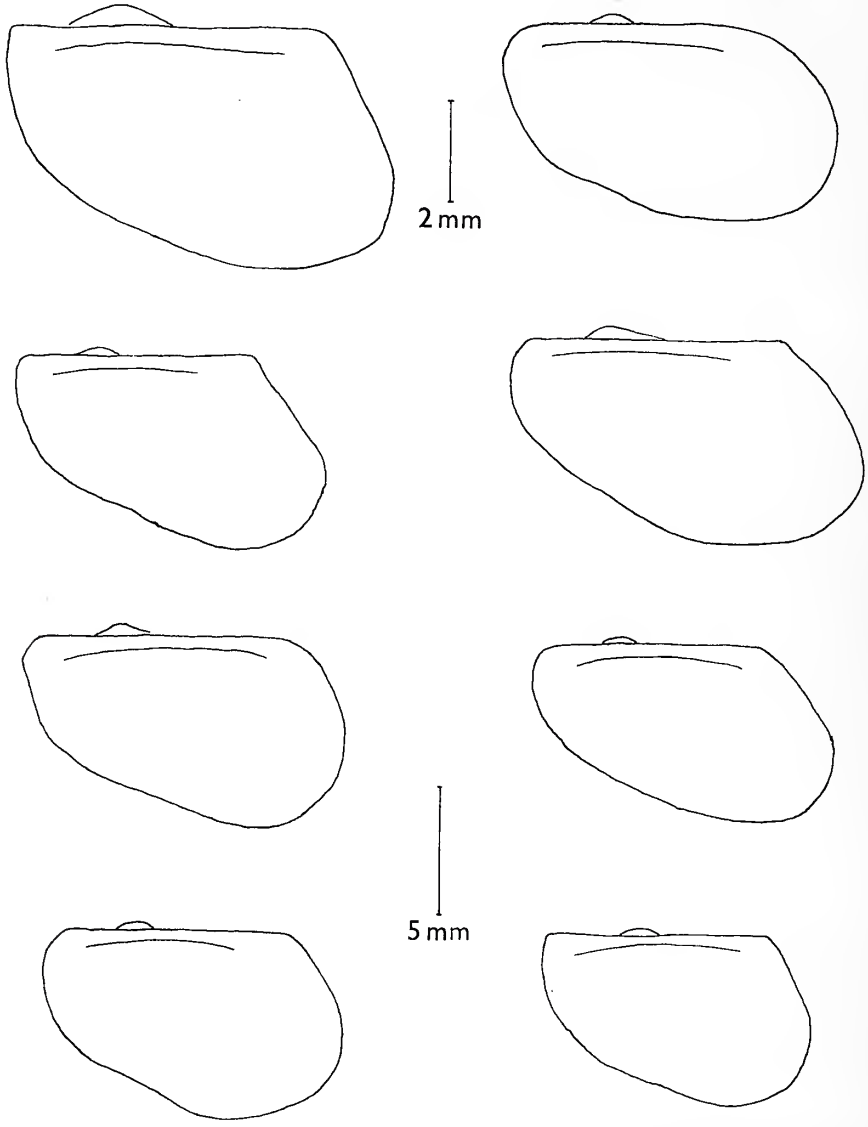


FIG. 10. *Acar asperula* (Dall); "*John Murray*" St. 26. Interiors of right valves to show the variation in the shape of the shell. The lower scale applies to the six lower valves.

DESCRIPTION: The shell is strongly inequilateral, the postumbonal part forming 66–71% of the total length. The dorsal edge is straight and forms 78–83% of the total length; it is marked off from the ventral edge of distinct rounded angles. The umbo is small and pointed. The ventral edge is rather variable in shape, particularly the posterior part. In most specimens a very shallow sulcus runs from the umbo to the ventral edge of the shell corresponding to the byssal sinus. The posterior part of the ventral edge forms an angle of 115–130° with the dorsal edge. In many specimens the postero-dorsal part of the ventral edge is nearly straight or slightly concave. The greatest height of the shell is attained at about half the distance between the umbo and the posterior end, and in all specimens the

height is equal to 56–65% of the total length. The periphery of the shell has a well-developed hairy brown periostracum which extends beyond the edge, particularly at the posterior end. The shell itself is greyish-white, and the sculpture consists of irregular concentric ridges. In some specimens these are rather distinct, but they may not be present in others. In addition, there is a fine radiating striation. The maximum breadth of the shell is attained somewhat posterior to the umbo and forms about 40% of the length of the shell. The ventral edge is smooth. The prodissoconch is present in most smaller specimens. It is distinctly marked off, somewhat inflated and smooth. It has a length of about 250 μ.

The hinge is long and narrow. The dentition of the hinge was found to vary considerably both as to the arrangement and number of teeth. The following numbers were found in specimens from St. 26:

Total length	7·4	8·2	8·7	9·6	9·9	10·1	10·2	10·5	10·7	10·9	11·4	11·5	11·6	11·7	12·0	15·0
Preumbonal	6	8	8	7	9	9	11	7	9	6	8	8	6	11	9	5
Postumbonal	5	6	8	4	6	7	6	6	7	6	6	6	7	6	5	6
Total	11	14	16	11	15	16	17	13	16	12	14	14	13	17	14	11

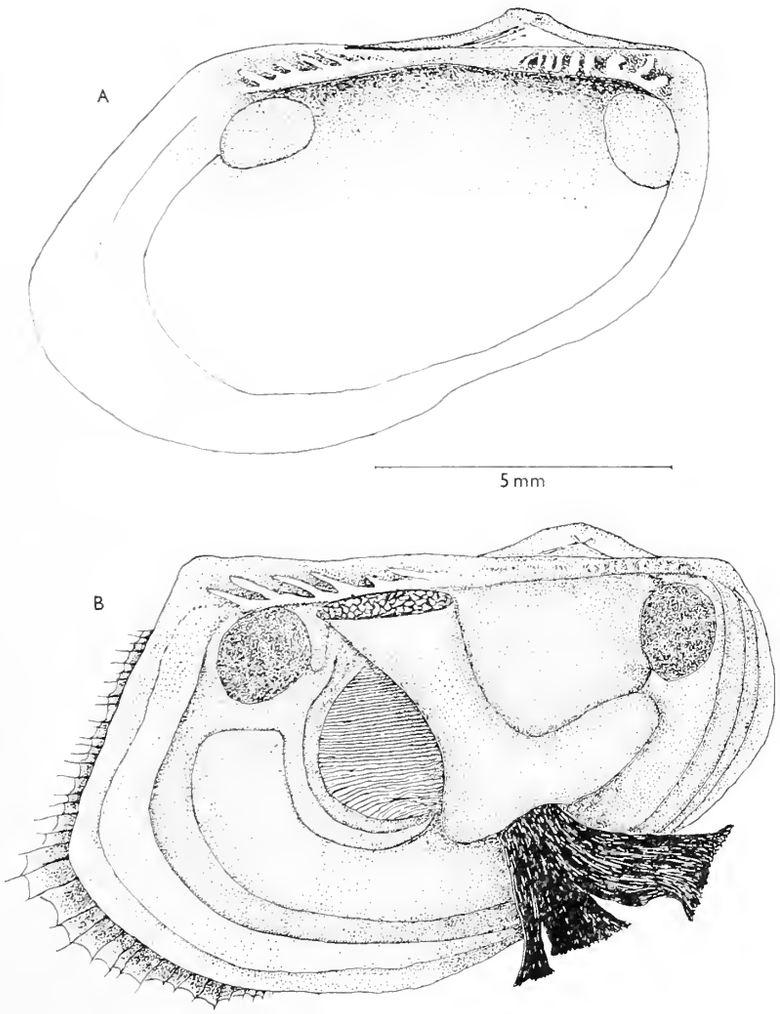


FIG. 11. *Acar asperula* (Dall); "*John Murray*" St. 26. (A) interior of left valve. (B) soft parts seen from the right side, right mantle and gill removed.

The number of preumbonal teeth varies between 5 and 11, while the number of postumbonal teeth was between five and eight. The total number of denticles varies between 11 and 17. The space between the anterior and posterior denticles may be smooth, but in most specimens there are one or two indistinct longitudinal folds. These have not been included in the countings. The anterior teeth

are generally arranged at right angles to the dorsal edge, except the most anterior two or three, which may diverge. The posterior teeth diverge in varying degrees, but as a rule, considerably more than the anterior teeth. The shape of the adductor scars varies somewhat. In some specimens the posterior scar may show a tendency to bipartition, and the anterior scar may be rounded-triangular in outline. The pallial impression is distinct. *The soft parts:* The mantle has a thickened rim at some distance from the edge. There is no development of posterior valves or siphon. The gill is rather small, the axis of the gill is solid, pointed, and in most specimens opened, anteriorly curved. The foot is well developed and provided with a well developed and solid byssus. The latter is elliptical in cross section with sharp anterior and posterior edges. The byssal cavity is relatively large, almost rhomboid or circular in section. The distal part of the byssus is somewhat expanded, and the byssus retractor is very well developed. Mantle eyes could not be detected. The anus is located on a slender papilla. The abdominal organ is very small and situated about one third of the distance to the visceral ganglia.

Remarks: Dall (1881) gave a detailed description of *M. asperula* but no figure. The species is characterized as excessively inequilateral and having a straight hinge-line. The beaks are situated just within the anterior third of the line, and a faint depression runs from the umbo to the ventral edge. The sculpture consists of concentric and radiating ribs. The shell has a brown, hairy epidermis. The hinge has six vertical anterior teeth and three horizontal posterior teeth. The species was obtained at several stations in the Gulf of Mexico by the "*Blake*" *Expedition*.

Smith (1885) described and figured *A. pteroessa* from the "*Challenger*" *Expedition*, from both the Atlantic and the Pacific Oceans. The species is characterized as being very inequilateral, pointed in front and greatly dilated and obliquely truncated behind. There is a slight depression radiating from the umbones to the ventral margin. The dorsal edge is rectilinear. The sculpture consists of concentric and radiating lirae. The hinge has eight anterior and ten posterior oblique denticles.

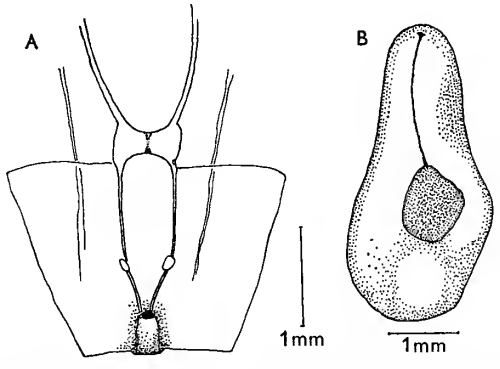


Fig. 12. *Acar asperula* (Dall); "*John Murray*" St. 26. (A) ventral view of abdominal organ. (B) ventral view of foot.

Verrill & Smith (in: Verrill (1885)) described and figured *A. profundicola* from the N.W. Atlantic ("*Albatross*" *Expedition*). The species is stated to be very inequilateral with the posterior end elongated and expanded. The umbo is somewhat flattened in the middle and a flattened or somewhat indented area extends from the umbo to the margin. The dorsal margin is straight and is about two-thirds the length of the shell. The posterior margin descends obliquely, or is slightly curved inwards, and then expands in a rounded curve. The sculpture consists of small wavy concentric ridges, and rather fine, regular radiating grooves, which are often a little nodulose when crossing the concentric ridges. The shell is covered with a rather coarse, dark-brown epidermis rising into elongated and conspicuous scales, and lamellae which become longer and more conspicuous posteriorly, where they form a fringe beyond the margin. The hinge has about six small anterior teeth which stand almost transverse to the margin. The number of posterior teeth is eight or nine; they are stated to be very oblique, slightly

raised ridges or folds, the two or three most posteriorly situated becoming less oblique and more conspicuous. Curiously enough, Verrill & Smith do not refer to the previously described species *M. asperula* in their description.

Dall (1886) gave good figures of both the external and internal side of the shell of *M. asperula*. Dall states that *Arca* (*Barbatia*) *pteroessa* E. A. Smith appears very similar in external appearance to *A. asperula*, but the hinge is different and the shell more produced behind. It is further added, that Verrill's *A. profundicola* is more finely striated, the lower posterior region less patulous and its hinge margin not so high. The anterior teeth are more – and the posterior less – oblique than in *A. asperula*.

Dall (1889) listed and figured both *A. asperula* and *A. profundicola* as separate species.

Dall (1908) described and figured *A.* (*Cucullaria*) *endemica*. The species was obtained by the "*Albatross*" *Expedition* in the S.E. Pacific. The shell is described as inequilateral, umbo located at about the anterior third, and the shell is minutely concentrically imbricate, radiately sculptured with numerous close, very fine threads. The anterior end is attenuated, short and pointed, the posterior broad, rounded and compressed. A shallow radial constriction extends basally from the beaks. The hinge is rectilinear; six vertical anterior teeth, eight oblique posterior teeth. The description is accompanied by a good figure of the shell's interior. Dall remarks that the species is very close to *Arca pteroessa* E. A. Smith, but has a coarser radial sculpture and fewer teeth. His figure shows the inside of a right valve, 11·5 mm long. The outline of this shell is within the range of variation observed in the "*John Murray*" material, as is the number of hinge teeth (six preumbonal and eight postumbonal). It would therefore seem reasonable to consider *A. endemica* as a synonym of *A. asperula*.

Dautzenberg (1927) synonymized *A. profundicola* and *A. pteroessa*, stating that the identity of *A. profundicola* Verr. and *pteroessa* Sm. cannot be doubted. Thiele & Jaeckel (1931) found that some of their specimens referred to as *A. profundicola* were rather smooth, while others had a sculpture similar to *A. asperula*, but less distinct. It is stated that *A. asperula* is close to *profundicola*, but is considered different from *asperula* because of the larger number of hinge teeth.

Prashad (1932a) recorded *A. incerta* Smith from the "*Siboga*" *Expedition*. The present author has had the opportunity of studying this material. The samples consisted apparently of several species, but samples from St. 221, 170 and 88, ranging in depth from 924 – 2798 m, are beyond doubt identical with the samples of the "*John Murray*" *Expedition* and also with the "*Galathea*" material.

Clarke (1962) kept *A. asperula*, *A. pteroessa*, *A. profundicola* and *A. endemica* as four separate species.

In addition to the "*Siboga*" material the author has also studied samples from the "*Challenger*", "*Investigator*" and "*Valdivia*" *Expeditions*. Thus, altogether, several hundred specimens from the Atlantic, Indian and Pacific Oceans have been examined, and as a result it is quite evident that the species is very variable as to outline of the shell, development of the sculpture and number and arrangement of hinge teeth. The variation is observed to be very large in all these characters within the same sample. However, variation in the shape of the shell is mainly due to differences in shape of the posterior part of the shell; the sculpture may be very distinct in some specimens, but rather obsolete in others. The preumbonal hinge teeth may be arranged at right angles to the dorsal edge or they may be oblique. Additionally, they may vary considerably in number, as shown above.

As a result of the examination of this comprehensive material, I consider that the four species *A. asperula*, *A. pteroessa*, *A. profundicola* and *A. endemica* should rather be united into one single species. This is strongly supported by comparison of the available descriptions and figures of the species in the papers already referred to.

Reproduction: Mature eggs in a single female from St. 26 were about 150 μ in diameter.

Attachment: Many specimens from St. 26 were found attached to the skeletons of a hexactinellid sponge, while others were attached to pieces of coke. In numerous cases the specimens were attached

to each other. The specimen from *Th. Mortensen* St. 29 was attached to the umbonal part of a shell of *Euciroa rostrata* Thiele & Jaeckel. In the "*Galathea*" material *A. asperula* was found in large numbers attached to *Limopsis pelagica* Smith; a few specimens were attached to dead coral or to pieces of terrestrial plants. It seems, therefore, that the present species is not selective as to choice of substratum but may use any kind of solid substratum for attachment. In the available samples numerous specimens were unattached. It is probable that the species is permanently fixed under normal conditions, but some specimens may have been detached during dredging and handling. The relatively large development of the byssus and the retractor appears curious in a species living in such deep and rather stagnant water; this type of development is rather to be expected in species living in shallow water with heavy water movement (such as a rocky shore).

Distribution: Dall (1881, 1886) recorded *M. asperula* from several "*Blake*" stations, of which live specimens are reported only from St. 33, Gulf of Mexico at a depth of 2869 m. Verrill (1885) mentioned live specimens from "*Albatross*" St. 2226, N.W. Atlantic at a depth of 3698 m. E. A. Smith (1885) reported *A. pteroessa* from several "*Challenger*" stations in the C. Atlantic and the Pacific. A re-examination of this material showed that specimens which had been alive at capture were found at St. 71, off the Azores at 1830 m depth; St. 237, N.W. Pacific, 3425 m; and at St. 246, C. Pacific, at a depth of 3752 m.

Verrill & Bush (1898) reported several findings in the N.W. Atlantic at depths ranging from about 1400–5000 m but made no statement as to the presence of live specimens. Smith (1904, 1906) recorded *A. pteroessa* from "*Investigator*" St. 111, Bay of Bengal, 3009 m and St. 316, S. of Ceylon, 2745 m. The material has been examined by the present author and both samples contained specimens which were alive at time of capture. Dall (1908) recorded *A. endemica* from the S.E. Pacific at depths between 3814 and 4035 m but did not mention the presence of live specimens. Grieg (1920) and Dautzenberg (1927) recorded *A. nodulosa* from a number of abyssal stations in the C. and E. Atlantic but made no statement as to the occurrence of live specimens. Dautzenberg's material has, however, been studied by the present author and the following "*Monaco*" stations, all from off the Azores, contained specimens alive at time of capture: St. 536, 2178 m; St. 650, 4400 m; St. 652, 4261 m; St. 698, 1846 m and St. 749, 5005 m. Soot-Ryen stated Grieg's material to consist of one live specimen from the C. Atlantic at 2615–2865 m depth. Thiele & Jaeckel recorded the species from two "*Valdivia*" stations off the W. coast of Africa, viz., St. 33, depth: 2500 m and St. 63, depth: 2492 m. The material has been examined by the present author, and specimens alive at capture were found at both stations. Prashad recorded *A. incerta* Smith from the S.E. Asian waters at depths ranging from 90 – 2798 m. This material has also been examined by the present author, and it was found that several species of *Arca* were erroneously included in the collection. The following "*Siboga*" stations contained specimens of *A. asperula* which had been alive at capture: St. 88, Macassar Strait, depth: 1301 m; St. 170, Ceram Sea, depth: 924 m, and St. 221, Banda Sea, depth: 2798 m. Okutani (1962) recorded live specimens from off Bosa Peninsula (W. slope of the Japan Trench) at a depth of 3150–3350 m. The as yet unpublished material collected by the "*Galathea*" *Expedition* contains material from the following regions (only live specimens are considered): W. Atlantic (St. 758), E. Atlantic (St. 24, 52), Indian Ocean (St. 281, 299, 314), S.E. Asian waters (St. 443), Tasman Sea (St. 550, 575) and W. Pacific (St. 663, 664). The bathymetrical range of the "*Galathea*" material is from 1500–4540 m. The above survey shows that *A. asperula* is known from all three oceans at depths ranging from 430 m (Th. Mortensen St. 29) down to 5005 m (Dautzenberg, 1927). The temperature range is from about 1·0 to about 9·0°C.

Family **LIMOPSIDAE**
Limopsis

A large number of species have been described within the genus *Limopsis*, all from shells only. Until recently however, practically nothing was known regarding the taxonomic characters that could be employed to distinguish the species, and the variation within the different species had been very superficially studied. Barnard (1964) states that "clear-cut diagnoses of species in this genus seem difficult to formulate" and calls attention to the varying obliquity of the shell. By measuring certain shell proportions Barnard was able to distinguish the four species of Limopsis known off S. Africa.

Dell (1964) undertook a revision of the antarctic species and studied the variability in some detail. Among his conclusions is the statement that shell sculpture and epidermal covering (when present) is very similar throughout the series, but that all other characters relied upon for species differentiation vary considerably. This also applies to the outline of the shell, which varies with age (size). Some populations tend to have very oblique shells, regardless of size. The strength of the hinge plate varies considerably, as does the relative size of the ligamentary fossette and other characters (the soft parts were not examined). Dell concludes: "Since many of the variations exist in a continuous series and since there is little, if any, geographical segregation of characters, it seems more probable that the degree of variation accepted in species of *Limopsis* must be considerably enlarged". – After having examined considerable material of abyssal *Limopsis* the present author cannot but agree with Dell's conception of the variability in *Limopsis*.

Limopsis pelagica E. A. Smith, 1885
Text fig. 13; *pl.* 1, *figs.* 12, 13, 14, 15.

1885 *Limopsis pelagica* E. A. Smith p. 254, pl. 18, fig. 3-3a.
1888 *Limopsis pelagica*, Pelseneer p. 12, pl. 2, fig. 1.
1898 *Limopsis transversa* Locard p. 326, pl. 15, figs. 11-14.
1912 *Limopsis pelagica*, Lamy p. 117.
1927 *Limopsis pelagica*, Dautzenberg p. 286.
1931 *Limopsis pelagica*, Thiele & Jaeckel p. 24.
1931 *Limopsis guineensis* Thiele & Jaeckel p. 25, pl. 1, fig. 17.
1962 *Limopsis guineensis*, Clarke p. 57.
1962 *Limopsis pelagica*, Clarke p. 57.
1962 *Limopsis transversa*, Clarke p. 57.

MATERIAL: *"John Murray" Expedition:* St. 26, Gulf of Aden, 12°29′30″N., 50°51′30″E.; depth: 2312 m; bottom: soft, grey white mud; bottom temperature: 2·7°C; gear: Agassiz trawl. – 3 juv. specimens.

St. 120, Zanzibar area, 5°49′12″S., 41°28′12″E.; depth: 2926 m; bottom: brown mud over grey globigerina ooze; bottom temperature: 2·2°C; gear: Agassiz trawl. – 3 specimens, 5 partly fragmented shells.

St. 185, Gulf of Aden, 13°48′06″N., 49°16′48″E.; depth: 2001 m; bottom: green mud; gear: Agassiz trawl. – 4 specimens, 1 shell.

Besides the material listed above, the present author has studied the material from the "*Galathea*" *Expedition* from the Atlantic and Indian Oceans (unpublished), and has also had the opportunity of studying material from the following earlier expeditions: "*Challenger*", "*Travalleur*" & "*Talisman*", "*Hirondelle*" and "*Valdivia*".

DESCRIPTION: *Two adults* from St. 185*:* The shells are strongly inequilateral and laterally compressed and have a rather small umbo. The epidermis has a thick coating of bristles; on the postero-ventral part of the shell in particular the bristles are strongly developed, but they have been completely

worn off around the umbo. The bristles are arranged in radiating rows; those recently formed are united by a fine transversely striated and hyaline membrane and have a broadened base (on which two bristles are usually developed). The shell proper has a fine and regular radiating sculpture crossed by a likewise fine and regular concentric sculpture. The ligament is small. The hinge plate has a regularly arched ventral edge; the number of preumbonal hinge teeth is 9 and 11 respectively, while the number of postumbonal teeth is 8 and about 10. The two rows of teeth are separated by an edentulous space. The interior of the shell is smooth. Both adductor scars are rounded, the anterior one being about half the size of the posterior. In both specimens a distinct ridge runs from the umbonal cavity along the posterior part of the anterior adductor scar. No such ridge is present posteriorly. The mantle impression is distinct. The inner margin is smooth.

DIMENSIONS IN MM:

Total length	Length of hinge	Length of fossette	Pos. of beak	Height
30·9	15·2	8·7	—	about 29
33·3	14·0	6·3	11·0	28·4

From the measurements and figures it appears that the two specimens vary considerably as to the shape of the shell, one being considerably more "oblique" than the other. *The soft parts* agree very well with the figure and description by Pelseneer (1888). The mantle edge is simple, somewhat thickened, and the three lobes are well developed. The gills are large. The foot is very large and strongly compressed, with a distinct triangular heel. The anus projects in the form of a short tube with lateral wings. The abdominal sense organs are small and rounded.

Juvenile specimens: One of the juveniles from St. 185 has a length of only 2·1 mm. It is equilateral and nearly circular in outline, and has a small projecting umbo. The epidermis has radiating rows of bristles, and the beginning of a concentric sculpture (fig. 13a & c). A specimen from St. 120 is 14 mm long. At this size the shell appears to be slightly inequilateral, and the dorsal edge is almost straight. The prodissoconch is visible in the juveniles and is about 200 μ in length.

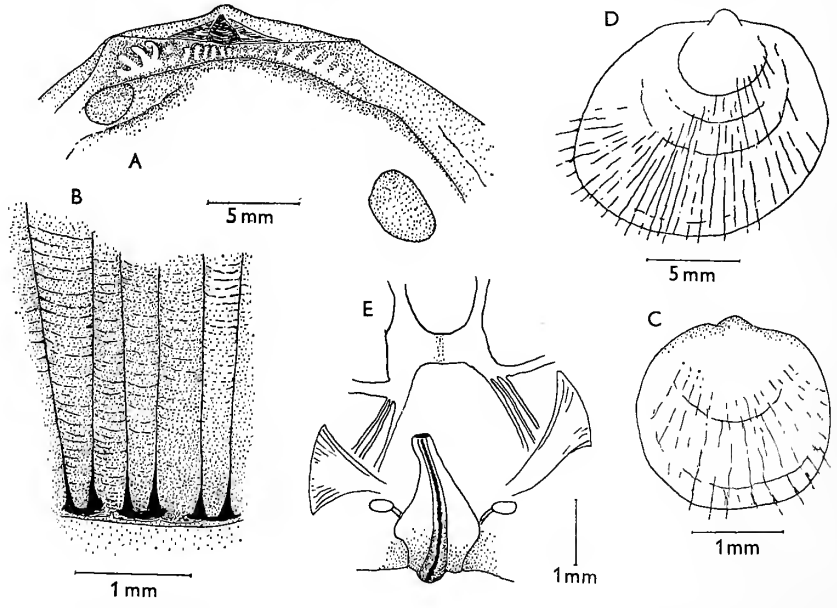


FIG. 13. *Limopsis pelagica* E. A. Smith; (D) from "*John Murray*" St. 120, the remaining figures from St. 185. (A) umbo and hinge of right valve. (B) arrangement of periostracal bristles from near the ventral edge of valve. (C) juvenile specimen, about 2 mm long and still symmetrical. (D) specimen about 14 mm long, distinctly inequilateral. (E) ventral view of abdominal organ.

REPRODUCTION: In the ovary of one of the adult specimens there were a few detached eggs, about 135 μ in diameter.

REMARKS: Smith (1885) described and figured *L. pelagica* from "*Challenger*", St. 106, at a depth of 3383 m and from St. 232, off Japan; depth: 631 m. The material of the latter station is stated to be a single shell minus animal.

Pelseneer (l. c.) described the soft parts of the species, his description being based on material from "*Challenger*" St. 106.

Although the present author has not seen this material it seems reasonable to assume that the shell from St. 232 is a species different from *pelagica*. Locard (1898) described and figured *L. transversa* from several stations in the N.E. Atlantic. The shells figured by Locard are very inequilateral and have a relatively small hinge compared to Smith's figures. Locard does not make any reference to Smith's species. I have examined some of Locard's material. St. 138, N. of the Azores, depth: 4787 m comprises two fine specimens and a few shells. Lamy (1917) considered *L. transversa* a synonym of *L. pelagica*. Dautzenberg (1927) listed *L. pelagica* from several stations in the N.E. Atlantic and listed *L. transversa* as a synonym. The present author has examined this material and found live specimens at four stations, St. 443, 527, 650 and 1306, at depths ranging from 3745–4400 m. This species was also reported by Thiele & Jaeckel (l. c.) from "*Valdivia*" St. 45, Gulf of Guinea, depth: 4990 m. However, they also described *L. guineensis* from "*Valdivia*" St. 56, Gulf of Guinea, depth: 2278 m. The present author has examined both samples, each consisting of one specimen with dry soft parts. A comparison of these specimens with numerous ones from the "*Galathea*" collection would seem to indicate that *L. guineensis* is a synonym of *L. pelagica* only. Clarke (1962) kept the three species mentioned here separate.

However, by comparing the "*John Murray*" specimens with the comprehensive collection of the "*Galathea*" *Expedition* (about 100 specimens), and the samples from earlier expeditions mentioned above, it would seem that they should all be referred to one quite variable species. The two large specimens from St. 185 are rather like *L. transversa* Locard as regards the outline of the shell, while the hinge is much more developed in the "*John Murray*" specimens than in Locard's species. A preliminary examination of the soft parts of "*Galathea*" specimens from the Indian Ocean (St. 281, 282, 299) failed to reveal any anatomical differences between these and the "*John Murray*" specimens. The outline of the shells of the "*Galathea*" material varies a great deal. In some specimens the obliquity is rather slight, as in the shell figured by Smith. In others, however, the shape is much more oblique, approaching that of the "*John Murray*" specimens.

Two species of abyssal *Limopsis* have been described from the N.W. Atlantic: *L. plana* Verrill and *L. profundicola* Verrill & Bush (in: Verrill & Bush, 1898). The former occurs at depths ranging from 2069–4061 m, the latter from 2789–3400 m. Judging from the available figures of these two species they are possibly conspecific with the present material. However, as the present author has not examined the material, no final decisions can be made. Dall (1908) described and figured *L. compressus* from the E. Pacific (Gulf of Panama) at depths ranging from 1952–4082 m. Both the description and the figure indicates a species which is extremely close to *L. pelagica*. The collection of the "*Galathea*" *Expedition* contains abyssal *Limopsis* from the same region, and the present author has studied some samples of abyssal *Limopsis* (also from this region) collected by expeditions from Scripps Institution of Oceanography. Altogether some 80–90 specimens are present. By comparing these with the "*Galathea*" samples from the Indian Ocean it has been tentatively concluded that *L. compressus* should be considered a synonym of *L. pelagica*. Barnard (1963) recorded an abyssal *Limopsis* from off S. Africa at depths ranging from 2268–3219 m, assigning it, with some doubt, to *L. straminea* Smith. This species was described from Kerguelen Isl. at a depth of 274 m. Dell (1964) synonymized *L. straminea* with *L. marionensis* Smith – a widely distributed antarctic and subantarctic species known from depths between 180–740 m. A renewed examination of Barnard's material might, however, prove this species to be *L. pelagica*.

Smith (1894) described and figured *L. indica* from "*Investigator*" St. 151, off Ceylon at a depth of 260–732 m, stating that the species resembles *L. pelagica* Smith, "but is not of quite the same form, has thicker more solid valves, and a coarser, more hairy epidermis". Smith (1895, 1904, 1906) recorded the species from the Arabian Sea, 2195 m depth ("*Investigator*" St. 229; 249; 269) and the Andaman Sea, 1399–1756 m ("*Investigator*" St. 309; 310). In addition, there are two records (Smith 1904, 1906) from 1408–1756 and 1930 m respectively, which could not be assigned to any "*Investigator*" station. The present author has examined three "*Investigator*" samples kept in the B.M.(N.H.), viz., from St. 127, depth: 2195 m, one specimen; St. 249, depth: 1869 m, one specimen and St. 269, depth: 849 m, two specimens. These samples appeared to belong to one species very closely related, or, rather, conspecific with *L. pelagica*. As already noted by Smith, the type of *L. indica* is very similar to *L. pelagica*. Since, however, it comes from a much shallower depth and has not been examined by the present author, a definite conclusion as to the relation between *L. indica* and *L. pelagica* cannot be reached. Prashad (1932a) recorded *L. indica* from two "*Siboga*" stations in the southeast Asian waters, viz., St. 95, depth: 522 m and St. 208, depth: 1886 m. Prashad states that all the specimens are greatly weathered and worn. The present author has seen the specimens in question. They proved to be in such a poor state that it is in fact not possible to assign a specific name to them.

DISTRIBUTION: *Limopsis pelagica*, in the conception outlined above is, thus known from the C. and E. Atlantic (and possibly also the W. Atlantic) and the Indian Ocean. The vertical range of live specimens would seem to be from 2001–4990 m. The temperature range is from 1·1–3·4°C.

Limopsis sansibarica Thiele & Jaeckel, 1931

Pl. 1, *figs.* 10, 11.

1931 *Limopsis sansibarica* Thiele & Jaeckel p. 26, pl. 1, fig. 22.

MATERIAL: "*John Murray*" *Expedition:* St. 109, Zanzibar area, 5°10′36″S., 39°33′48″E.; depth: 640 m; bottom: light grey mud; bottom temperature: 8·9°C; gear: Agassiz trawl. – 1 specimen. St. 184, Gulf of Aden, 14°36′06″N., 51°00′18″E.; depth: 1270 m; bottom: green mud; gear: Agassiz trawl. – 2 valves (apparently from the same specimen).

DESCRIPTION: The shell is thick, approximately equal in height and length. The epidermis is yellowish-brown and without the bristles found in the "*Valdivia*" material. The dorsal edge is straight and forms about 55% of the length. The umbo is small. The sculpture consists of irregular concentric ridges which become more pronounced towards the periphery. The radiating sculpture is indistinct on most of the shell and only posteriorly does it develop into real ridges; on the rest of the shell it consists mainly of radiating rows of small pits. Similar pits are also present on the posterior ridges. The prodissoconch has a length of about 200 μ. The hinge has seven teeth on both sides of the umbo. The anterior teeth are arranged almost at right angles to the dorsal edge, while the posterior ones are somewhat diverging. The ligament is short, forming about 20% of the length of the dorsal edge. The adductor scars are very distinct. The circular anterior scar is located just below the hinge; the posterior, located at about half the distance to the ventral edge, is elongate, and about double the size of the anterior scar. A fine ridge runs from the umbonal cavity to the ventral edge of the anterior adductor scar. The edge of the shell has a fine regular crenulation.

DIMENSIONS IN MM: The valves from St. 184: 18·7 × 18·2 × 11·4. The type measures 9 × 9 × 4·5.

REMARKS: The present material agrees very well with the description and figure of Thiele & Jaeckel (1931). The description mentions the radiating rows of pits and the crenulation, which can also be observed in the figure. The present author has examined the "*Valdivia*" material and although this material consists of smaller specimens, the largest being about half the size of the two valves from "*John Murray*" St. 184, there is no doubt that they are identical with the latter.

DISTRIBUTION: Thiele & Jaeckel recorded the species from four stations off the E. coast of Africa. Two stations contained specimens which were alive at time of capture, viz., St. 242, depth: 404 m, St. 245, depth: 463 m. Thus the vertical range of the species is 404–640 m (possibly 1270 m). The temperature range is from 8·9–11·1 °C.

Family **MYTILIDAE**

Amygdalum politum (Verrill & Smith, 1880)

Text fig. 14.

1880 *Modiola polita* Verrill & Smith in: Verrill p. 400.
1881 *Modiola polita*, Verrill p. 402.
1881 *Modiola polita*, Dall p. 116.
1882 *Modiola lutea* P. Fischer p. 52.
1882 *Modiola polita*, Verrill p. 578.
1884 *Modiolaria polita*, Verrill p. 281, pl. 30, fig. 12.
1885 *Modiola watsoni* E. A. Smith p. 275, pl. 16, fig. 5-5c.
1886 *Modiola polita*, Dall p. 234, pl. 6, fig. 3.
1891 *Modiola sp.*, Wood-Mason & Alcock p. 19.
1895 *Modiola watsoni*, E. A. Smith p. 14.
1898 *Modiola polita*, Locard p. 357.
1904 *Modiola watsoni*, E. A. Smith p. 11.
1906 *Modiola watsoni*, E. A. Smith p. 254.
1911 *Modiola watsoni*, Pelseneer p. 17, pl. 4, fig. 10, 11, pl. 5, fig. 1.
1928 *Modiolus watsoni*, Melvill p. 113.
1931 *Modiolus watsoni*, Thiele & Jaeckel p. 11.
1932a *Modiolus* (*Amygdalum*) *watsoni*, Prashad p. 74, pl. 2, figs. 32, 33.
1955 *Modiolus politus*, Nicklès p. 124.
1959 *Brachidontes* (*Amygdalum*) *watsoni*, Kira p. 114, pl. 45, fig. 5.
1962 *Modiolus* (*Amygdalum*) *politus*, Clarke p. 58.
1962 *Modiolus* (*Amygdalum*) *watsoni*, Clarke p. 58.
1962 *Musculus* (*Amygdalum*) *watsoni* Kira p. 127, pl. 46, fig. 5.
1966 *Amygdalum politum*, Soot-Ryen p. 9.

MATERIAL: *"John Murray" Expedition:* St. 34, Gulf of Aden, 13°05′36″N., 46°24′42″E.; depth: 1022 m; bottom: green mud; bottom temperature: 10·2 °C; gear: Agassiz trawl. – 7 specimens.

St. 193, Gulf of Aden, 13°06′12″N., 46°24′30″E.; depth: 1061–1080 m; bottom: green mud; bottom temperature: 10·9 °C; gear: Agassiz trawl. – 5 specimens.

Th. Mortensen leg.: St. 52, Banda Sea, 5°46′S., 132°49′35″E.; depth: 352 m; bottom: mud; gear: trawl. – 1 specimen.

"Galathea" Expedition: St. 302, Bay of Bengal, 19°42′N., 86°48′E.; depth: 1190 m; bottom: clay; gear: sledge trawl. – 3 specimens.

St. 443, Mindanao Sea, 8°48′N., 124°09′E.; depth: 1500 m; bottom: mud, many fragments of plants; gear: sledge trawl, dredge. – 6 specimens.

DESCRIPTION: The shell is modioliform, very thin and fragile; smaller specimens are semi-transparent. The periostracum of larger specimens may be reddish-brown, particularly on the anterior part of the shell. The sculpture is faintly developed and consists of an irregular concentric striation. In addition, a very delicate radiating striation may be found. The interdissoconch has a length of 1·5–2·0 mm; it is very distinctly marked off and remains whitish, even in specimens in which the periostracum is reddish-brown. The prodissoconch has a length of about 400 μ. The resilial ridge is faintly developed and devoid of pits, and the ligament forms about 40% of the length of the shell.

The adductor scars are very indistinct; the anterior scar is narrow and elongate and located close to the anterior end of the shell, while the posterior scar is roughly circular and located near the postero-dorsal corner. *Soft parts:* in preserved specimens the soft parts appear to be very small compared to

the size of the shell. The mantle edge is smooth, and the siphonal opening completely devoid of tentacles. The foot is vermiform with a distinct ventral byssal slit. The anterior retractor is fastened in the umbonal cavity. The posterior retractor is bipartite; the smaller anterior part is fastened about two-thirds the distance between the umbo and the posterior edge of the shell, while the larger posterior part is fastened close to the posterior adductor. In several specimens a well-developed byssus is present. A few specimens have a "nest", which in one case is mainly built of fragments of silicious sponges, while in another, the nest is constructed mainly of mud.

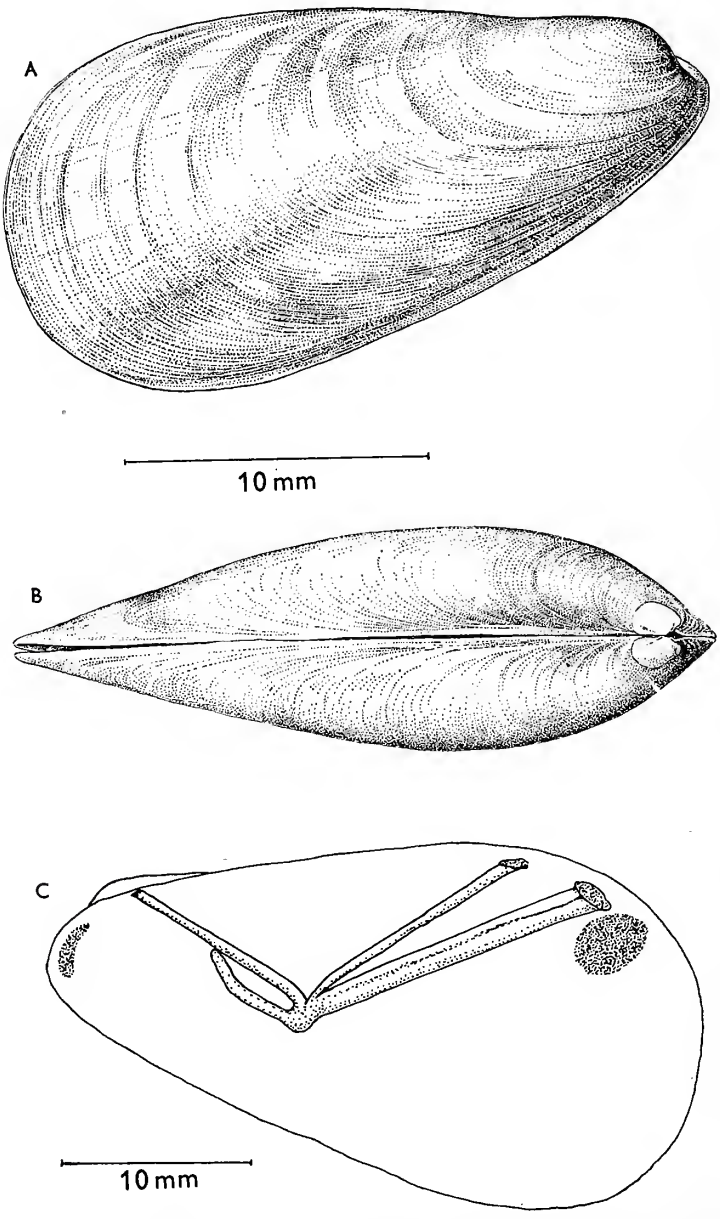


FIG. 14. *Amygdalum politum* (Verrill & Smith); (A, B) "*Galathea*" St. 302, P.H.W. (C) "*John Murray*" St. 34. (A) lateral view of right valve. (B) dorsal view. (C) interior of right valve showing adductors, foot and pedal retractor.

DIMENSIONS IN MM: The length of the largest specimen examined ("*Thor*" *Expedition*) is 51 mm. Prashad 1932a mentions a shell being 52 mm long.

REPRODUCTION: The species is unisexual (Pelseneer 1911). Several mature females are found in the present material; the eggs have a diameter of 60–70 μ.

FOOD: Samples of stomach content were taken from specimens from "*John Murray*" St. 34 and from "*Galathea*" St. 443, and examined by Dr. J. B. Hansen of the Botanical Museum of the University, Copenhagen. The "*John Murray*" sample contained numerous diatoms (*Coccinodiscus*, *Bidulphia*) radiolarians and *Globigerina* and several slender bristles possibly originating from small crustaceans. The "*Galathea*" sample also contained diatoms as well as flagellates, Foraminifera, a single nematode and remnants of small (unidentified) crustaceans.

REMARKS: The description given by Verrill & Smith (1880) is very brief and not accompanied by a figure. P. Fischer (1882) described *M. lutea* (based on material from the "*Travailleur*" *Expedition*), but again without a figure. Verrill (1884) gave the first figure of the species. Smith (1885) described and figured *M. watsoni*, but made no reference to either *M. polita* or *M. lutea*. Dall (1886) gave a description of *M. polita* in which the soft parts are also mentioned. The shell was figured; he listed *M. lutea* as a synonym. Locard (1898) reporting on the material of the "*Travailleur*" and "*Talisman*" *Expeditions*, also considered *M. lutea* a synonym of *M. polita*. Pelseneer (1911) gave an account and good figures of the gross anatomy of *M. watsoni*.

Besides the material listed above, the present author has had at his disposal two samples (kept in the Zoological Museum of the University, Copenhagen), viz., "*Thor*" *Expedition*, St. 43, E. Atlantic (off the W. coast of Portugal), 1500 m depth and "*Atlantide*" *Expedition* St. 120, Gulf of Guinea, 260–650 m depth. Both samples consist of specimens with preserved soft parts; the "*Atlantide*" sample was reported by Nicklès (1955). In addition to these two samples the present author has seen material from the following expeditions: "*Challenger*", "*Travailleur*" & "*Talisman*", "*Investigator*", "*Siboga*" and "*Valdivia*". When comparing these samples it was found that they should, beyond doubt, be referred to as one and the same species, *M. polita*. Not only were the shells practically identical in shape and sculpture, but some variation in colour of the shell was found, the smaller specimen being generally of a lighter colour than the longer ones. A careful comparison of the soft parts of the "*John Murray*" and "*Galathea*" specimens with the "*Thor*" and "*Atlantide*" material failed to show any differences, and the anatomy of the specimens agreed completely with the figures given by Pelseneer (l. c.), based on specimens from the "*Siboga*" *Expedition*.

DISTRIBUTION: Verrill (1880, 1881, 1882) recorded *M. polita* (live specimens) from the N.W. Atlantic at a depth of 436 m. E. A. Smith (1885) described *M. watsoni* from two "*Challenger*" stations (191 and 207) in the S.E. Asian Sea at depths of 1281 and 1464 m. Live specimens were found at both stations. Dall (1886) recorded *M. polita* from the Gulf of Mexico and the W. Indian waters at "*Blake*" St. 43 and 47, at depths of 587 and 620 m. Locard (l. c.) reported *M. polita* from a number of stations from the "*Travailleur*" and "*Talisman*" *Expeditions*. At the following five stations from the E. Atlantic between the Bay of Biscay and off Morocco, live specimens were present: 2, 7, 8, 20, and 28, at depths ranging from 322–1143 m. The "*Investigator*" *Expedition* Wood-Mason & Alcock (1891a, b), Smith (1895, 1904, 1906) found the species at several stations in the Indian Ocean (both in the Bay of Bengal and the Arabian Sea), at depths ranging between 315 and 1240 m. No mention is made of the presence of live specimens. Soot-Ryen (1966) revising the bivalves of the *Michael Sars Expedition* 1910 found that the specimens which Grieg (1920, 1931) referred to as *Modiola polita* in fact should be referred to as *Dacrydium vitreum* and *D.*sp. Melvill (1928) recorded the species from several localities in the Gulf of Oman at depths ranging from 73–366 m, but does not mention the presence of live specimens. In view of the hitherto known bathymetrical range of *M. polita*, its presence recorded at a depth of 73 m seems remarkable, and should be regarded as doubtful until the material has been re-examined. Thiele & Jaeckel (1931) reported *M. watsoni* from the E. Indian Ocean (W. of Sumatra), St. 185, 186, 190 and 191, and from off E. Africa (Zanzibar area). The depth range of these stations is from 404–1280 m. Only the sample from St. 186, depth: 903 m, contains a live specimen. Prashad (l. c.) recorded the species from ten stations in the S.E. Asian waters. Live specimens were present at

the following five stations: 5, 52, 208, 271 and 314, at depths ranging from 330–1886 m. Kira (1959, 1962) recorded the species from off Japan at depths ranging from 91–146 m.

From this survey it appears that *A. politum* occurs in the W. Atlantic from roughly 45°N. to the W. Indies, and in the E. Atlantic from the Bay of Biscay to the Gulf of Guinea. In the Indian Ocean it is known from off E. Africa (shells only), the Arabian Sea, the Bay of Bengal and W. of Sumatra. It is further known from the S.E. Asian waters eastwards to the Philippines and off Japan, while it appears to be absent from the E. Pacific (Soot-Ryen, 1955). The bathymetrical range would be from 330–1886 m, and the temperature range from about 3·3 to about 11·5°C.

Family **PECTINIDAE**

Propeamussium sibogai (Dautzenberg & Bavay, 1904)

Pl. 1, *figs.* 23, 24.

1904 *Amussium sibogai* Dautzenberg & Bavay p. 207, figs. 1-4.
1912 *Amussium sibogai*, Dautzenberg & Bavay p. 31, pl. 28, figs. 1-4.
1944 *Luteamussium sibogai*, Oyama p. 240.
1951 *Luteamussium sibogai*, Oyama p. 82, fig. 1.
1959 *Luteamussium sibogai*, Kira p. 122, pl. 48, fig. 14.
1962 *Luteamussium sibogai*, Kira p. 138, pl. 49, fig. 14.

Material: *Dr. Th. Mortensen leg.:* The Philippines, 25 miles E. by S. of Zamboanga; depth: 300–380 m; gear: Sigsbee trawl. – 3 specimens.

St. 51, Banda Sea, 5°46′30″S., 132°51′E.; depth: 348 m; bottom: mud; gear: trawl. – 3 specimens.

"Galathea" Expedition: St. 196, off Durban, S. Africa, 29°55′S., 31°20′E.; depth: 450–435 m; bottom: sandy mud with stones; gear: sledge trawl. – 7 specimens.

St. 436, Philippines, E. of Cebu, 10°12′N., 124°14′E.; depth: 710 m; bottom: green mud; gear: sledge trawl, dredge. – 1 specimen.

St. 500, Arafura Sea, 7°34′S., 132°44′E.; depth: 390 m; bottom: sand, stones; gear: dredge. – 1 specimen.

Description: The species is large for the genus. The shells are somewhat inequivalve, the left valve being more convex than the right; the auricles are relatively small. The shells have a characteristic orange-yellow colour which is stronger in the left than in the right valve. The costae have a rather strong brownish colour. The shells gape considerably at both ends. Except for irregular concentric growth lines no sculpture is present. In the right valve the extracostal zone is very distinctly marked off from the rest of the shell. The prodissoconch measures about 210 μ in length. The ligament is small and triangular. The number of costae is seven in all shells seen; they are broad and triangular in section. They increase considerably in breadth towards the periphery, and are rounded at the distal end. The auricular costae are provided with a number of rounded whitish nodules (four or five on each costa in the largest specimens). The remaining costae sometimes have a terminal nodule, but this is not found in the majority of the shells. *The soft parts:* both mantle edges have equally developed tentacles, which are close-set and of varying lengths. Eyes could not be detected. The well-developed velum is without tentacles. The region of the mantle edge is devoid of pigment, except that in one specimen a few tentacles had a brown colouration. The foot is well-developed, having a long slender basal part and a large terminal disc.

Dimensions in mm: Present material: 53 × 51.

Reproduction: In one female apparently ripe eggs were present measuring 160–180 μ in diameter.

Food: The stomach content has been examined in five specimens. It proved to consist of small crustaceans (Isopoda, Copepoda, Ostracoda) and Foraminifera, with no admixture of detritus.

Remarks: The present species is easily identifiable by fine figures given by Dautzenberg & Bavay (1912) and Kira (1962).

DISTRIBUTION: Dautzenberg & Bavay based the species on a single live specimen obtained by the "*Siboga*" *Expedition* (St. 12) in the S.E. Asian waters at a depth of 289 m. Oyama (1951) recorded the species from the waters off Japan, but does not give exact information about depth, nor did he make any statement as to the presence of live specimens. He does mention that the species has been found in the Tosa Bay and off Kyushu and Shikoku. Kira states the depth range to be from about 146 to about 183 m. The present material demonstrates the presence of *P. sibogai* off S.E. Africa. Besides the above-mentioned records, the collections of the Copenhagen Museum contain a specimen showing traces of the dry soft parts, collected off Nota, Japan Sea (at about 38°N. and 137°E.) at a depth of 290 m. The U.S.N.M., Washington, D.C. contains a sample from Tosa Bay, S.E. Japan, depth: 183 m with specimens alive at capture, and three samples from off the Philippines at depths between 280 and 410 m ("*Albatross*" *Philippine Expedition* 1907–1910, St. 5325, 5374, 5409 and 5454). These samples have been seen by the present author. Thus the total range of the present species would seem to be from the Japan Sea and off S.E. Japan to S.E. Africa at about 30°S. The known vertical range of live specimens would be from about 183–710 m. It is possibly found living at even shallower depths off Japan. The temperature range would seem to be from about 6·5 to about 12°C.

Amussium andamanicum E. A. Smith, 1894

Text fig. 15; *pl.* 1, *fig.* 22.

1894 *Amussium andamanicum* E. A. Smith p. 172, pl. 5, figs. 13, 14.
1895b *Amussium andamanicum*, E. A. Smith p. 265.
1897 *Amussium andamanicum*, Alcock & Anderson pl. 2, fig. 1, 1a.
1904 *Amussium andamanicum*, E. A. Smith p. 14.
1940 *Amusium andamanicum*, Winckworth p. 26.

MATERIAL: "*John Murray*" *Expedition:* St. 119, Zanzibar area, 6°29′24″S., 39°49′54″E.; depth: 1207–1463 m; bottom temperature: 6·2°C; gear: Agassiz trawl. – 2 specimens.

St. 185, Gulf of Aden, 13°48′06″N., 49°16′48″E.; depth: 2000 m; bottom: green mud; gear: Agassiz trawl. – 4 specimens.

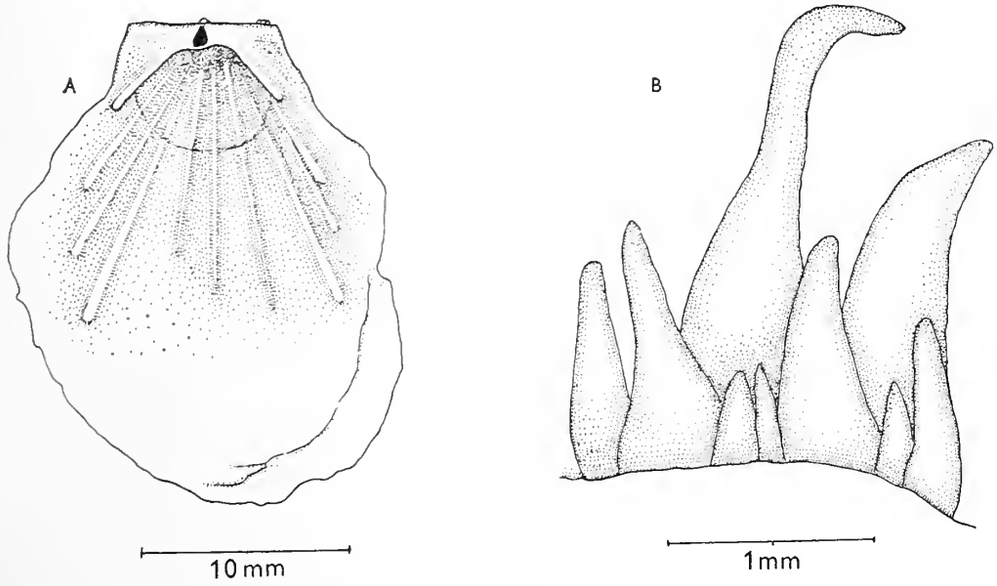


FIG. 15. *Amussium andamanicum* E. A. Smith; "*John Murray*" St. 119. (A) interior of left valve. (B) tentacles of the middle lobe of the mantle.

DESCRIPTION: The shell is very thin and hyaline. The height of the shell is roughly one-and-a-half times the length. The left valve is slightly convex, while the right is nearly flat. The auricles are relatively small. The left valve has irregular concentric undulations and fine irregular concentric lines, and the right has a fine regular concentric striation. Both valves are without radiate sculpture. The ligament is small and triangular. The prodissoconch has a length of about 250 μ. The number of costae is nine or ten; they are narrow, of nearly the same breadth throughout, and without terminal nodules. In the left valve one to three central costae are shorter than the others and pointed distally, while the remaining ribs are blunt. *The soft parts:* the outer mantle lobe is small and without tentacles. The middle lobe is provided with close-set, pointed tentacles of varying size. Both the lobes and the tentacles are without pigment, and eyes could not be detected. The velum is very well-developed, but without tentacles. The basal part of the lobe has brown pigment arranged in radiating bands. The interior surface of the mantle has a distinct brown pigmentation along the periphery. The foot is small and bulbous distally. The labial palps are provided with a strong, distinct pigmentation, and this may also be the case with the whole dorsal part of the body.

DIMENSIONS IN MM: Smith (1895) recorded a specimen measuring 43 × 51. The largest specimens of the present material are only about half that size.

FOOD: The stomachs of two specimens have been examined. In both cases the content consisted of small crustaceans, mostly ostracods, and in one of the specimens a small fish vertebra was found.

REMARKS: The present material agrees well with the description and figures of Smith (1894) and Alcock & Anderson (1897) except that the proportion of height to length is about twice that of the present shells. This seems, however, to be due to the fact that the anterior and posterior parts of the shells have been broken off.

DISTRIBUTION: Smith (l. c.) mentions the species from the following "*Investigator*" stations: St. 102, Andaman Sea, 1259–1687 m; St. 122, Laccadive Sea, 1583–1610 m and St. 192, Arabian Sea, 1737 m. However, no mention is made as to whether live specimens or shells only were obtained. The distribution of the species would seem to include the whole N.W. part of the Indian Ocean. The present material indicates the vertical range of the species to be from 1207–2000 m. The temperature range of the species is from 3·4 to about 6·2°C.

Amussium caducum E. A. Smith, 1885

Text fig. 16; *pl.* 1, *fig.* 17.

1885 *Amussium caducum* E. A. Smith p. 309, pl. 23, fig. 1-1c.
1894 *Amussium caducum*, E. A. Smith p. 173.
1895a *Amussium caducum*, E. A. Smith p. 18.
1904 *Amussium caducum*, E. A. Smith p. 13.
1906 *Amussium caducum*, E. A. Smith p. 255.
1907 *Amussium caducum*, Melvill & Standen p. 807.
1912 *Amussium weberi* Dautzenberg & Bavay p. 32, pl. 28, figs. 9-13.
1931 *Amussium caducum*, Thiele & Jaeckel p. 7.
1932 *Propeamussium nakazawai* Kuroda p. 87, figs. 101, 102.
1940 *Amusium caducum*, Winckworth p. 26.
1951 *Parvamussium* (*Flavamussium*) *caducum*, Oyama p. 81, pl. 13, figs. 11, 12.
1958a *Flavamussium caducum*, Habe p. 267, pl. 11, fig. 26.
1959 *Parvamussium* (*Flavamussium*) *caducum*, Kira p. 122, pl. 48, fig. 15.
1962 *Parvamussium* (*Flavamussium*) *caducum*, Kira p. 138, pl. 49, fig. 15.

MATERIAL: "*John Murray*" *Expedition:* St. 33, Gulf of Aden, 13°41′N., 48°17′E.; depth: 1295 m; bottom: grey mud; bottom temperature: 7·2°C; gear: Agassiz trawl. – 11 specimens.

St. 108, Zanzibar area, 5°18′06″S., 39°24′12″E.; depth: 786 m; bottom: grey mud; bottom temperature: 7·9°C; gear: Agassiz trawl. – About 30 specimens, 25 shells.

St. 193, Gulf of Aden, 13°06′12″N., 46°24′30″E.; depth: 1061–1080 m; bottom: green mud; bottom temperature: 10·9°C; gear: Agassiz trawl. – 5 specimens.

Th. Mortensen leg.: S.W. of Tucuran, Philippines, 7°30′N., 123°30′E.; depth: 548 m; bottom: mud; gear: Sigsbee trawl. – 3 specimens, 5 shells.

"*Galathea*" *Expedition:* St. 436, E. of Cebu, Philippines, 10°12′N., 124°14′E.; depth: 710 m; bottom: green mud; gear: sledge trawl and dredge. – 6 specimens.

St. 443, Mindanao Sea, 8°48′N., 124°09′E.; depth: 1500 m; bottom: mud, many fragments of plants; gear: sledge trawl and dredge. – 3 specimens.

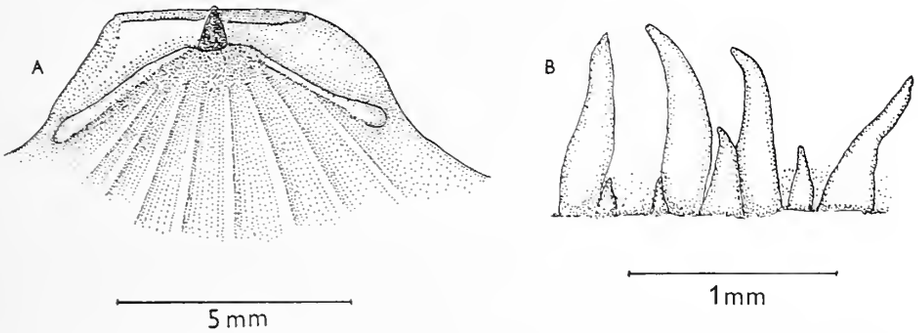


FIG. 16. *Amussium caducum* E. A. Smith; "*John Murray*" St. 108. (A) umbonal part of left valve. (B) tentacles of the middle lobe of the mantle.

DESCRIPTION: The shell is thin and fragile, somewhat higher than long, and the left valve is somewhat more convex than the right. The right valve is transparent-white and the left distinctly brown. The auricles are relatively small and separated from the rest of the shell by a sharp ridge. The anterior auricle is slightly smaller than the posterior one, and the valves gape at both ends. The right valve has a fine regular concentric striation, while the left, and the auricle, are devoid of sculpture. The dorsal edge is short and straight and without serrations. The prodissoconch is about 215 μ long. The number of costae is generally ten, but some valves have nine or eleven. The costae increase gradually in size towards the periphery and are slightly nodulose at the distal end. *The soft parts:* the middle lobe of the mantle is provided with close-set pointed tentacles of varying sizes. Most of the tentacles have a brown pigment, but otherwise the region of the mantle edge is unpigmented. Eyes could not be seen. The velum is very well-developed and devoid of tentacles. The foot and labial palps are small. The region round the foot and labial palps has a distinct brown pigmentation.

DIMENSIONS IN MM Dautzenberg & Bavay (1912): 23 × 27.

FOOD: The stomach content of five specimens was examined. It consisted of small Crustacea (Copepoda, Cumacea and Ostracoda) and a few Foraminifera.

REPRODUCTION: Mature eggs were found in several specimens, and had a diameter of about 150 μ.

REMARKS: The present material agrees very well with the description and figures of Smith (1885). It is mentioned that ten costae were present. Dautzenberg & Bavay, in their description of *A. weberi*, stated that it is very closely related to *A. caducum*, but differs in having nine costae only and in the shape of the auricles of the right valve (which in *A. weberi* extend beyond the dorsal edge of the shell). As already mentioned, the number of costae of the present material was found to vary between nine and eleven. The shape of the auricles of the right valve is also variable. In one of the specimens of the sample collected by *Th. Mortensen* the auricles have very much the shape shown in Dautzenberg & Bavay's fig. 10; in other valves, however, the auricles do not project beyond the dorsal edge. The author is therefore of the opinion that *A. weberi* should be synonymized with *A. caducum*. Kuroda (1932) figured *P. nakazawai* as a new species, but no description is given. The figures show shells with

eleven costae, and in general shape the species is very similar to the present material. Oyama (1951) considered Kuroda's species a synonym of *A. caducum*, but did not discuss the problem. Habe (1958) also considered *A. nakazawai* a synonym of *A. caducum*, a conception also shared by the author.

DISTRIBUTION: Smith (1885) described *A. caducum* from "*Challenger*" St. 207, off the Philippines at a depth of 1280 m. Later, the same author (1894, 1895, 1904 and 1906) recorded the species from nine "*Investigator*" stations, both in the Arabian Sea and the Bay of Bengal, at depths ranging from about 691–1483 m. Melville & Standen (1907) list the species without giving the depths. Dautzenberg & Bavay mention *A. weberi* from five "*Siboga*" stations in the S.E. Asian waters at depths between 462 and 724 m. Jaeckel & Thiele (1931) recorded *A. caducum* from two "*Valdivia*" stations off the W. coast of Sumatra at 677 and 750 m depths. Oyama, Habe & Kira recorded *A. caducum* from a number of localities off the S.E. part of Japan (S. of about 35°N.) at a depth of about 200 m. However, none of the above-mentioned authors mentions the presence of live specimens. The collections of the Zoological Museum of Copenhagen contains a united pair of valves (with dry soft parts) from Tosa Bay, S.E. Japan, depth about 190 m (leg. K. Tuji, det.: G. Grau). The present collection would indicate a vertical range of live specimens from 190–1500 m. The temperature range of the species would be from about 5·2–11 or 12°C.

Amussium jeffreysi E. A. Smith, 1885
Pl. 1, *fig.* 19.

1885 *Amussium jeffreysii* E. A. Smith p. 310, pl. 23, fig. 2-2c.
1894 *Amussium jeffreysii*, E. A. Smith p. 173.
1940 *Amusium jeffreysii*, Winckworth p. 26.
1951 *Ctenamussium (Bathyamussium) jeffreysii*, Oyama p. 79, pl. 13, figs. 1, 2.
1958a *Bathyamussium jeffreysi*, Habe p. 267, pl. 11, fig. 20.
1961 *Bathyamussium jeffreysi*, Habe p. 118, pl. 52, fig. 3.
1964 *Bathyamussium jeffreysi*, Habe p. 173, pl. 53, fig. 3.

MATERIAL: "*John Murray*" *Expedition:* St. 143, Maldive area, 5°15′48″S., 73°22′48″E.; depth: 797 m; bottom: green sand; bottom temperature: 7·9°C; gear: Agassiz trawl. – About 70 specimens.

St. 145, Maldive area, 4°58′42″S., 73°16′24″E.; depth: 494 m; bottom: green mud, sand; bottom temperature: 10·9°C (at 400 m depth); gear: Agassiz trawl. – About 300 specimens, about 25 shells.

St. 176, Gulf of Aden, 12°04′06″N., 50°38′36″E.; depth: 655–732 m; bottom: green mud, sand; gear: Agassiz trawl. – 7 shells.

"*Galathea*" *Expedition:* St. 196, off Durban, S. Africa, 29°55′S., 31°20′E.; depth: 430 m; bottom: sand and clay; gear: Petersen grab. – 1 specimen.

DESCRIPTION: The shell is thin, semi-transparent, almost equivalve and slightly higher than long. The left valve is somewhat more convex than the right and has a brownish colour; the right valve is white. The left valve has a fine regular latticed sculpture, which is distinct near the umbo, but tends to become obsolete towards the periphery. The right valve has a distinct concentric sculpture covering all the surface, but no radiating sculpture. The auricles are relatively small, about equal in size, and with sculpture. They are separated from the rest of the shell by a distinct, sharp ridge. The valves gape anteriorly and posteriorly. The prodissoconch is about 210 μ long, and the ligament is small and triangular. The number of internal costae is 12 in most valves, but 13 are found in some; these costae are narrow near the umbo but gradually increase towards the periphery. The anterior and posterior ribs have a distinct terminal nodule which is less developed or absent in the central costae. In some valves one or two secondary costae may be developed, and here they are generally observed in (one or two) anterior or posterior intercostal spaces, and are rarely found in the central intercostal spaces. The secondary costae often appear as isolated terminal nodules, but in several shells a real costa is

developed, running from the periphery towards the umbo. It is observed that the secondary costae never reach more than about half the distance between the terminal nodule and the umbo. *The soft parts:* the left mantle edge has a distinct brown pigment consisting of a narrow brown band running close to the edge of the velum. From this, irregular radiating patches run towards the mantle edge, and in addition, most of the tentacles are pigmented. The right mantle is similar to the left, but without pigment. The middle lobe of the mantle edge is provided with numerous close-set tentacles, while no tentacles are present in the velum. Eyes could not be detected. The foot is small and almost cylindrical. Most specimens have brownish pigment on the labial palps and in the region posterior to the foot.

Dimensions in mm: Present material about 21 × 21.

Reproduction: A number of mature females are present, containing eggs with diameters ranging from 110–140 μ.

Food: The stomach content has been examined in seven specimens from St. 145, and proved to consist of small crustaceans (copepods and ostracods could be recognized) and some Foraminifera. A specimen from St. 143 contained Foraminifera only. In no cases was detritus found in the stomach.

Remarks: The present material agrees very well with the description and figures of Smith (1885). Two of his figures show shells provided with secondary costae in the same way as the present material.

Distribution: Smith (1885) recorded the species from "*Challenger*" St. 210, off the Philippines at a depth of about 690 m and the same author (1894) recorded it from "*Investigator*" St. 135, off Goa, 1051 m depth. Oyama (1951) and Habe (1958, 1961) recorded the species from a number of localities off S.E. Japan. In one case the depth is stated to be 514 m. None of the above records states whether live specimens or shells were obtained. Two shells in the collections of the Zoological Museum of Copenhagen (kindly donated by Mr. G. Grau, Los Angeles), have distinct traces of soft parts, and come from Tosa Bay, Japan, depth 290 m. The species is thus known from off E. Africa to off S.E. Japan. The vertical range of live specimens would be from 290 m down to 797 m. The temperature range would seem to be from about 8 to about 12·5°C.

Amussium meridionale E. A. Smith, 1885

Text fig. 17; *pl.* 1, *fig.* 16.

1885 *Amussium meridionale* E. A. Smith p. 316, pl. 24, fig. 1, 1a.
1959 *Propeamussium meridionale*, Grau p. 12, pl. 1.
1960 *Varlamussium meridionale*, Powell p. 175.
1962 *Verlamussium meridionale*, Clarke p. 60.

Material: "*John Murray*" *Expedition:* St. 62, Northern area of Arabian Sea, 22°53′30″N., 64°56′10″E.; depth: 1893 m; bottom: grey clay; bottom temperature: 4·0°C; gear: Agassiz trawl. – 14 specimens.

St. 120, Zanzibar area, 5°49′12″S., 41°28′12″E.; depth: 2926 m; bottom: brown mud over grey globigerina ooze; bottom temperature: 2·2°C; gear: Agassiz trawl. – 2 specimens.

St. 162, Maldive area, 8°08′30″N., 72°58′E.; depth: 1829–2051 m; bottom: grey mud; gear: Agassiz trawl. – 2 specimens.

St. 185, Gulf of Aden, 13°48′06″N., 49°16′48″E.; depth: 2000 m; bottom: green mud; gear: Agassiz trawl. – 9 specimens.

Description: The valves are hyaline and somewhat iridescent, the left one somewhat more convex than the right. The right valve has a fine, regular concentric striation covering its surface, and

also present is a delicate radiating sculpture. In the left there are some irregularly spaced concentric lines and a tendency towards concentric undulation. In addition, there is a radiating sculpture consisting of irregularly-spaced fine ridges. Usually, the dorsal edge is slightly concave; that of the left valve is generally serrated, while that of the right is nearly smooth. The auricles are subequal in size. The anterior edge of the anterior auricle is convex. The prodissoconch has a length of about 200 μ. The ligament is very small, triangular. The number of costae is 11 in all specimens seen; they are distinctly marked off and increase gradually in size towards the periphery, but are without a distinct terminal nodule. *The soft parts:* both mantle edges have equally developed, close set tentacles, but no eyes could be seen. In nearly all specimens a narrow brown band is observed some distance from the base of the tentacle; it is present in both mantle edges. The tentacles are without pigment. No tentacles are present on the velum.

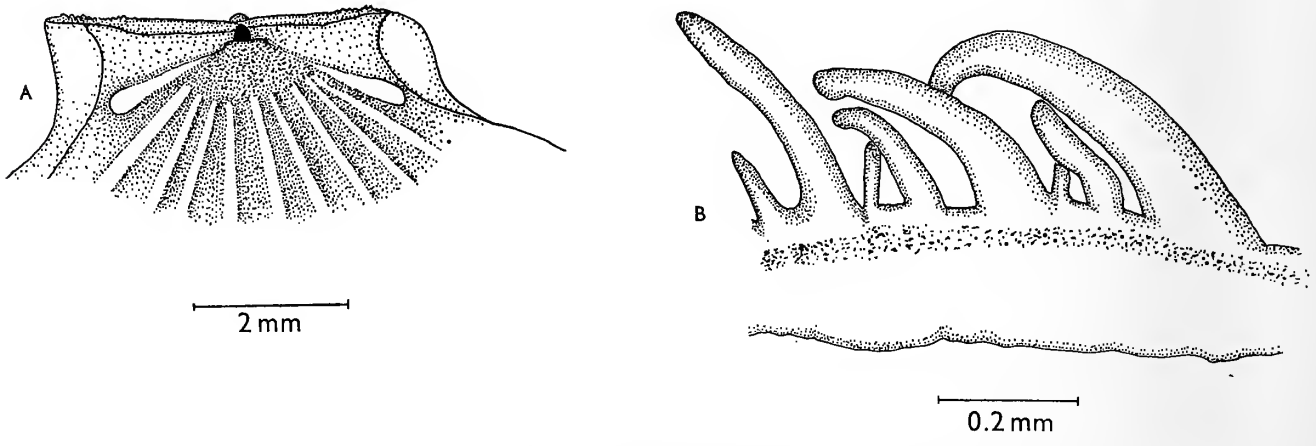


FIG. 17. *Amussium meridionale* E. A. Smith; "*John Murray*" St. 162. (A) umbonal part of left valve. (B) tentacles of the middle lobe of the mantle.

DIMENSIONS IN MM: The largest "*John Murray*" specimen measured 15 × 15.

FOOD: The stomach content (examined in three specimens) consisted of small crustaceans, among which Ostracoda and Copepoda could be recognized. The stomachs examined contained no detritus.

REMARKS: The present material has been compared with specimens from the "*Challenger*" material and was found to agree to such an extent that there can hardly be any doubt with regard to identification. Smith states the number of costae to be 11, although 12 were sometimes present; the serrations on the dorsal edge were also found in the "*Challenger*" material.

DISTRIBUTION: The "*Challenger*" *Expedition* obtained this species at three widely separated stations: St. 146, in the S.W. part of the Indian Ocean; St. 158, S. of W. Australia and St. 302, S.E. Pacific, at depths ranging between 2516 and 3294 m. The material from St. 146 and St. 302 has been examined by the present author and both samples contained specimens with soft parts. The present material constitutes a considerable extension of the known area of distribution of the species, also comprising the northern part of the Indian Ocean. The "*Galathea*" *Expedition* (unpublished), dredged *A. meridionale* from eight stations between the E. coast of Africa and the W. Pacific (Kermadec area) at depths down to 4810 m. Thus, the total known horizontal distribution of *A. meridionale* would seem to comprise the whole of the Indian Ocean and the southern part of the Pacific with a vertical range from 1893–4810 m. The temperature range would be from 1 to about 4°C.

Amussium sewelli n. sp.

Text fig. 18*A*, *B; pl.* 2, *figs.* 1, 2.

MATERIAL: *"John Murray" Expedition*: St. 118, Zanzibar area, 4°05′54″S., 41°10′12″E.; depth: 1789 m; bottom: globigerina ooze; bottom temperature: 3·0°C; gear: Agassiz trawl. – 2 specimens.

DIAGNOSIS: An *Amussium* having 11 costae and a mantle edge provided with an external row of small bulbous tentacles and two internal rows of larger pointed tentacles of varying sizes.

DESCRIPTION: The shell is transparent and somewhat higher than long, the left valve being somewhat larger and more convex than the right. The left valve has a distinct and regular concentric sculpture; the central part of the valve has a somewhat less distinct radiating sculpture which tends to become obsolete towards the periphery. The right valve has only a regular concentric sculpture. In the type the right valve has a faint brown colouration, whilst the left is completely white (in the paratype both valves are white). The auricles are relatively small, nearly equal in size and provided with a transverse sculpture which is slightly more distinct on the anterior auricle than on the posterior. The prodissoconch is about 290 μ long. Eleven costae are present. They are distinctly marked off and gradually become broader towards the periphery. The central costae are devoid of terminal nodules, while indistinct nodules are found on the anterior and posterior costae. *The soft parts:* the middle lobe of the mantle has three rows of tentacles. The tentacles of the external row are very small and bulbous distally. The tentacles of the two inner rows are considerably larger, pointed and of varying sizes. The velum is very well developed and without tentacles. The mantle edge, as well as the remaining part of the body is devoid of pigment. The foot is very small and bulbous distally.

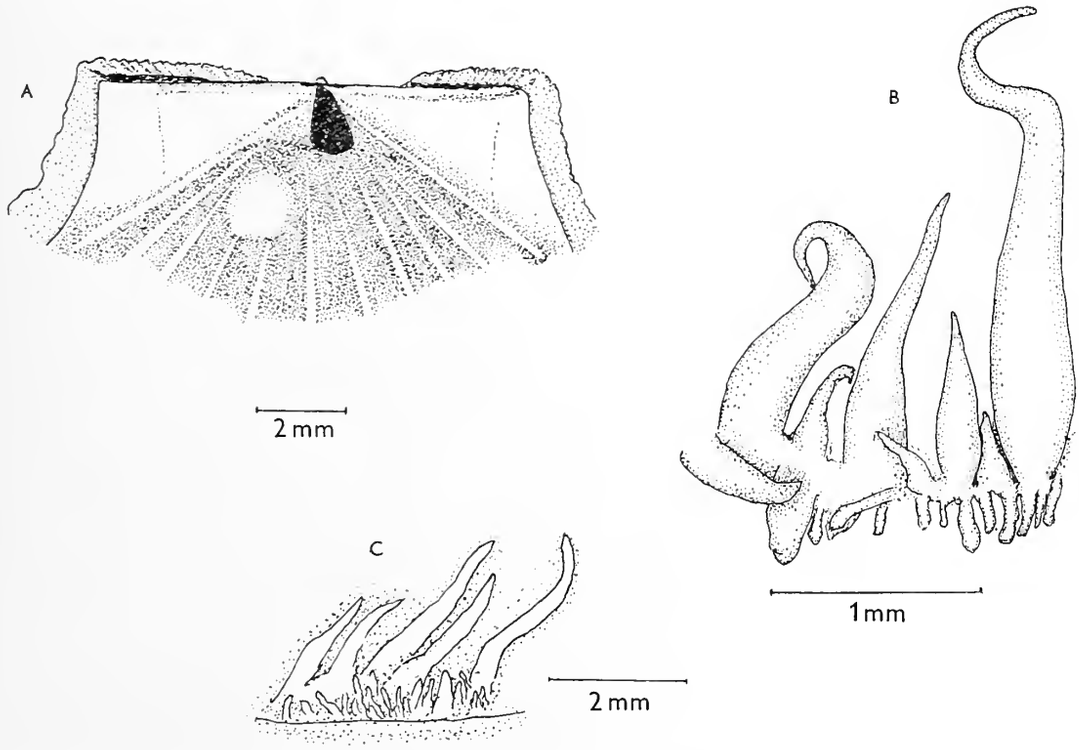


FIG. 18. (A, B) *Amussium sewelli* n. sp.; *"John Murray"* St. 118. (A) type, umbonal part of right valve. (B) paratype, external view of tentacles of the middle lobe of the mantle. (C) *Amussium watsoni* E. A. Smith; *"John Murray"* St. 124. Tentacles of the middle lobe of the mantle.

DIMENSIONS IN MM: Type: right valve: 27 × 32; left valve (approximately): 36 × 34.

RELATIONSHIP: Smith (1906; p. 255, 256) described two species of *Amussium*, viz., *A. investigatoris* and *A. manaricum*. The former from *"Investigator"* St. 248, 410–519 m depth; the latter from

"*Investigator*" St. 322 and 333, 691 and 733 m depth. These species have never been figured. As far as can be judged from the descriptions, the present species seems to be different from these. *A. investigatoris* has 10 costae, while *A. manaricum* has 15. *A. sewelli*, with 11 costae, seems to be rather close to *A. watsoni* (below), which also has 11 costae. These two species differ in the shape of the auricles, and *A. sewelli* does not have the reflection of the posterior edge of the posterior auricle found in *A. watsoni*. In addition, these two species differ in the arrangement of the tentacles of the mantle edge, *A. watsoni* lacking the small bulbous tentacles.

The species is named for Dr. R. Seymour Sewell, the leader of the "*John Murray*" *Expedition.*

HOLOTYPE: B.M.(N.H.) Reg. No. 196641 W.

PARATYPE: B.M.(N.H.) Reg. No. 196642 W.

Amussium steindachneri Sturany, 1901

Pl. 1, *figs.* 20, 21.

1901 *Amussium steindachneri* Sturany p. 269, pl. 4, figs. 9-12.
1907 *Amussium steindachneri*, Melvill & Standen p. 808.
1929 *Amusium steindachneri*, Cox p. 207.

MATERIAL: "*John Murray*" *Expedition:* St. 207, Red Sea, 14°08′56″N., 42°19′E.; depth: 375 m; bottom: green brown mud, pteropod shells; gear: Petersen grab. – 10 shells (some have the ligament preserved).

DESCRIPTION: The shell is small and hyaline and without sculpture, except that both auricles of the left shell have a fine, regular, transverse striation. The length of the shell is less than the height. The dorsal edge is straight and the anterior auricle is larger than the posterior one. The former has a convex anterior edge, and the right valve has a distinct longitudinal edge along the base. The posterior edge of the posterior auricle is nearly straight. The prodissoconch is 200 μ long. The ligament is very small, triangular. The number of costae is six in all specimens seen. The ribs are white and rather prominent. Near the umbo they are very narrow, but increase considerably towards the periphery. The terminal nodules are not developed. The two most anterior ribs are curved towards the anterior edge of the shell distally, while the three most posterior ribs diverge towards the posterior edge.

DIMENSIONS IN MM: The largest shell in Sturany's material is 13·7 × 14·0. The shells of the present collection are somewhat smaller, the largest being about 10 × 9.

REMARKS: The present species is easily identified by the good description and figures given by Sturany.

DISTRIBUTION: Sturany recorded the species from two stations in the southern part of the Red Sea at depths of 439 and 457 m. Melvill & Standen (1907) report *A. steindachneri* from the Gulf of Oman, at depths of 256–375 m. Cox (1929) did not add any new localities. The known distribution thus extends from the Red Sea to the Gulf of Oman at depths ranging from 256–457 m. Unfortunately, no live specimens of *A. steindachneri* have been recorded.

Amussium watsoni E. A. Smith, 1885

Text fig. 18*C*; *pl.* 1, *fig.* 18.

1885 *Amussium watsoni* E. A. Smith p. 309, pl. 22, fig. 8-8c.
1891 *Amussium sp.*, Wood-Mason & Alcock p. 18.
1894 *Amussium alcocki* E. A. Smith p. 172, pl. 5, figs. 15, 16.
1897 *Amussium alcocki*, Alcock & Anderson pl. 2, figs. 3, 3a.
1902 *Amussium alcocki*, Alcock p. 282, fig. 79.
1906 *Amussium alcocki*, E. A. Smith p. 255.
1931 *Amussium alcocki*, Thiele & Jaeckel p. 8.
1940 *Amusium alcocki*, Winckworth p. 26.
1962 *Propeamussium watsoni bayonnaisense* Okutani p. 15, pl. 2, figs. 1, 2.
1962 *Amussium watsoni*, Clarke p. 61.

MATERIAL: *"Investigator" Expedition:* St. 105, Malabar coast, 15°2′N., 72°34′E.; depth: 1354 m; bottom: grey ooze, globigerina ooze; bottom temperature: 6·7C°. – 2 specimens and 1 shell.
"John Murray" Expedition: St. 124, Zanzibar area, 5°39′S., 39°39′24″E.; depth: 914 m; bottom: grey green mud, sand; bottom temperature: 6·9°C; gear: Monégasque trawl. – 2 specimens, 1 shell.
"Galathea" Expedition: St. 324, Strait of Malacca, 6°38′N., 96°00′E.; depth: 1140 m; bottom: brownish globigerina ooze; gear: sledge trawl. – 1 specimen.

DESCRIPTION: The species is distinctly inequivalve, the right valve is smaller than the left and nearly flat. The shell is higher than long and inequilateral, the postumbonal part of the shell being the larger. In lateral view the postero-dorsal edge is only slightly curved. The valves are somewhat gaping at both ends. Some specimens are provided with a regular concentric sculpture in the right valve; this feature was observed in the "*John Murray*" specimens, but in both the "*Investigator*" and the "*Galathea*" specimens the right valves are nearly smooth and have only a fine irregular striation. The left valve has a fine concentric sculpture which is particularly distinct on the peripheral part of the shell and consists of fine, irregularly spaced ridges. The umbonal part of the left valve is provided with a faint regular radiating sculpture which becomes obsolete towards the periphery. All the left valves have two faint rounded ridges on the posterior part running from the umbo to the postero-ventral margin. The auricles are small and subequal in size. The posterior edge of the posterior auricle is somewhat reflected, as is the anterior edge of the anterior auricle to a lesser degree. The prodissoconch is eroded in all shells. The ligament is very small. The number of costae is 11 in all shells examined. The anterior and posterior costae (three at both ends) are somewhat stronger than the central ones; they are rather close together and often provided with terminal nodules or blunt at the distal end. The central five costae are somewhat finer and pointed distally. It would appear that the costae of the right valve are stronger than those of the left. *The soft parts:* the middle lobe of the mantle is provided with close-set pointed tentacles, but no eyes could be seen. The velum is very well developed and devoid of tentacles. The "*Galathea*" specimen had a band of brown pigment at the base of the tentacles on the left side only, but all other specimens lacked this feature. The foot is small and bulbous distally.

DIMENSIONS IN MM: Smith (1885): 50 × 52.

FOOD: The stomach content was examined in two specimens and was found to consist of ostracods and remnants of other small, unidentified crustaceans. One of the specimens examined had a fragment of a hydrotheca belonging to a hydroid.

REMARKS: The present material agrees well with Smith's (1885) description and figure of *A. watsoni*. Smith (1894) noticed that *A. alcocki* is very closely related to *A. watsoni*, but differs in being "not so rounded, the right valve has more feeble concentric sculpture, and the radiating lines of the left valve are not so strong". The "*John Murray*" specimens have been compared to the types of *A. alcocki* kept in the B.M.(N.H.), and found to be identical. The "*Investigator*" specimen listed above comes from the type locality and was probably identified by E. A. Smith himself. After having studied the present material I feel inclined to consider *A. alcocki* a synonym of *A. watsoni*. In both species the shell has the same general shape (including the auricles) and the same number and arrangement of costae. The differences between the two species pointed out by Smith could well be due to interspecific variation. The description by Okutani (1962) also fits the present material very well, and the figures given certainly confirm that Okutani actually had Smith's species in front of him. Okutani's specimens were referred to subsp. *bayonnaisense* owing to the fact that the dorsal edge was not serrated. Smith states that in *A. watsoni* the dorsal edge may sometimes be serrated. There seems some doubt as to whether Okutani's subspecies can be upheld.

DISTRIBUTION: E. A. Smith (1885) described *A. watsoni* from "*Challenger*" St. 218, N.E. of New Guinea at a depth of 1958 m. The type was a live specimen. Later, Smith recorded *A. alcocki* from the following three "*Investigator*" stations: St. 105 (part of the sample is in the Copenhagen Museum),

depth: 1354 m; St. 112, Bay of Bengal, 1026 m and St. 275, Laccadive Sea, depth: 1337–1410 m. Concerning the two last-mentioned stations, no information is available as to the presence of live specimens. Thiele & Jaeckel (1931) recorded *A. alcocki* from "*Valdivia*" St. 271, the Gulf of Aden, depth: 1469 m, but did not state whether shells or live specimens were found. Okutani (1962) reported *A. watsoni* from off S.E. Japan, "*Soyo-Maru*", St. B 4 at depths of 2140–2160 m and states that live specimens were obtained. It would thus appear that *A. watsoni* has a horizontal distribution extending from off E. Africa (Zanzibar area) to off S.E. Japan and New Guinea, and that the vertical range is from 914–2160 m. The temperature range is from about 2·0–6·9°C.

The collection of M.C.Z., Harvard, contains a fine specimen with dry soft parts which is labelled "*Amussium alcocki* Smith, Bay of Bengal, 700 fathoms". The specimen, which has been seen by the present author, was probably taken by the "*Investigator*" *Expedition*, but no station of that depth is recorded in the station list for the region indicated on the label.

Pecten alcocki E. A. Smith, 1904

Text fig. 19; *pl.* 2, *figs.* 3, 4.

1904 *Pecten alcocki* E. A. Smith p. 13.
1907 *Pecten alcocki*, Alcock, Annandale & Mc.Gilchrist pl. 18, figs. 4, 4a-b.
1931 *Pecten* (*Pseudamussium*) *alcocki*, Thiele & Jaeckel p. 6.
1940 *Propeamussium* (*Hyalopecten*) *alcocki*, Winckworth p. 26.

MATERIAL: "*John Murray*" *Expedition:* St. 176, Gulf of Aden, 12°04′06″N., 50°38′36″E.; depth: 655–732 m; bottom: green mud, sand; gear: Agassiz trawl. – 17 shells.

St. 177, Gulf of Aden, 12°01′54″N., 50°39′12″E.; depth: 274–366 m; bottom: green mud, rock; gear: Agassiz trawl. – 2 shells.

"*Galathea*" *Expedition:* St. 423, E. of Cebu, Philippines, 10°27′N., 124°18′E.; depth: 750 m; bottom: green mud; gear: sledge trawl. – 1 specimen.

St. 436, E. of Cebu, Philippines, 10°12′N., 124°14′E.; depth: 710 m; bottom: green mud; gear: dredge and sledge trawl. – 14 specimens.

DESCRIPTION: The shell is orbicular and semi-transparent, the anterior auricle somewhat larger than the posterior. The dorsal edge forms about three-quarters of the diameter of the shell, and the right valve has a well-developed byssal sinus. The sculpture consists of radiate rows of fine scales running from the umbo to the edge of the shell and connected by fine concentric lines. The anterior auricle of the right valve has 3–4 radiating ridges and a concentric lamellose sculpture. In some specimens the scales may have worn off the central part of the shell. The prodissoconch has a length of about 280 μ. The ligament is small and triangular. *Soft parts:* the mantle edge is provided with numerous pointed tentacles which fall into two size groups, with two or three smaller tentacles usually found in the interstices between larger ones. In addition, the mantle edge has very distinct irregularly spaced eyes; these are pear-shaped, and attached by the narrow end. The distal part of the eye is strongly pigmented. There is a well-developed velum provided with small regularly spaced tentacles. The mantle edge has a very distinct pigmentation consisting of brownish irregular radiating bands from the base of the larger tentacles towards the edge of the velum. In some specimens the central part of the mantle has relatively large irregular patches of brown pigment, and this is also found in all specimens on the posterior part of the gill, on the body posterior to the foot, and posterior to the posterior adductor. This characteristic pigmentation is readily observed through the shell. The foot is small and cylindrical and slightly inflated at the distal end. The byssus is well developed. Most of the specimens from "*Galathea*" were attached to silicious sponges.

DIMENSIONS IN MM: The largest "*John Murray*" shell measures 15 × 15.

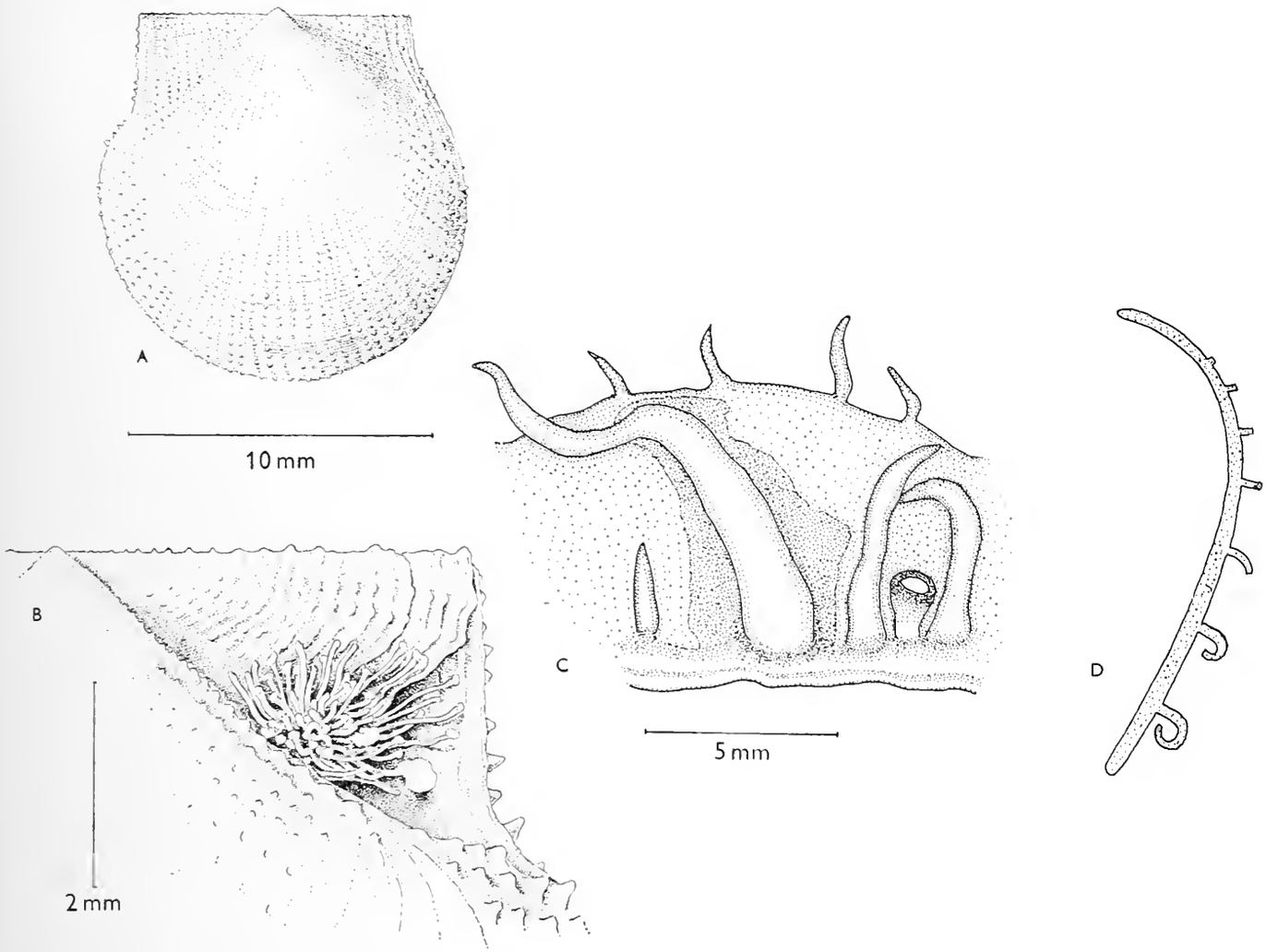


FIG. 19. *Pecten alcocki* E. A. Smith; "*Galathea*" St. 436. (A) lateral view of left valve. (B) anterior right auricle, byssal sinus and byssus. (C) mantle edge, including velum, tentacles and eyes. (A, B) P.H.W. (D) *Lucina inanis* Prashad. Diagrammatic cross section of shell.

REMARKS: The present material agrees very well with the fine figure given by Alcock, Annandale & McGilchrist (1907). Thiele & Jaeckel (1931) are rather inclined to believe that *P. alcocki* might be a variety of the widely distributed *P. vitreus* Chemnitz. The "*Valdivia*" material has been examined by the present author who agrees with Thiele & Jaeckel's identification, and also found that the present collection is most definitely conspecific with that of the "*Valdivia*". In order to investigate more closely Thiele & Jaeckel's suggestion that *P. alcocki* might only be a variety of *P. vitreus*, some specimens of the latter from the N. Atlantic were examined. The shells are rather similar in the two species but are more hyaline in *P. vitreus*; in addition, the latter has a fine concentric sculpture, not present in *P. alcocki*, and there are very obvious differences in the region of the mantle edge. Eyes and pigment are absent in *P. vitreus*, and the edge of the well-developed velum is devoid of tentacles; a large number of small tentacles are, however, present on the external surface of the velum. It would thus appear that *P. alcocki* is specifically different from *P. vitreus*.

DISTRIBUTION: Smith recorded *P. alcocki* from "*Investigator*" St. 232, off S. India, 786 m depth, but gives no indication of live specimens. Thiele & Jaeckel recorded *P. alcocki* from five "*Valdivia*" stations: St. 191, depth: 750 m; St. 194, depth: 614 m; St. 196, depth: 646 m; St. 198, depth: 677 m

and St. 264, depth: 1079 m. The first four are found in the region W. of Sumatra, while the last is off E. Africa. I found specimens with dry soft parts present at St. 191, 194 and 196. Thus, until now, live specimens are known from off Sumatra eastwards to off the Philippines, but shells only are known from the N. and W. part of the Indian Ocean. The known vertical range would be from 614–750 m, and the temperature range from 7·3 to about 12°C.

Family **UNGULINIDAE**

Cryptodon bisecta (Conrad, 1849)

Pl. 2, figs. 7, 8.

1849 *Venus bisecta* Conrad p. 724.
1895a *Cryptodon investigatoris* E. A. Smith p. 13, pl. 2, fig. 6, 6a.
1895 *Cryptodon bisectus*, Dall p. 713, pl. 26, figs. 2, 5.
1896 *Cryptodon investigatoris*, E. A. Smith p. 374.
1897 *Cryptodon investigatoris*, Alcock & Anderson pl. 3, figs. 2, 2a-b.
1901 *Thyasira bisecta*, Dall p. 789.
1904 *Cryptodon investigatoris*, E. A. Smith p. 10.
1906 *Cryptodon investigatoris*, E. A. Smith p. 257.
1921 *Thyasira bisecta*, Dall p. 33.
1925 *Thyasira bisecta*, Yabe & Nomura p. 84, pl. 23, figs. 2-10, pl. 24, figs. 2-4.
1931 *Thyasira investigatoris*, Thiele & Jaeckel p. 60.
1931 *Thyasira bisecta*, Grant & Gale p. 281.
1942 *Thyasira investigatoris*, Winckworth p. 27.
1958 *Conchocele disjuncta* Nakazima p. 186, 1 plate.
1958b *Conchocele disjuncta*, Habe p. 26, pl. 2, fig. 5.
1961 *Conchocele disjuncta*, Habe p. 124, pl. 56, fig. 15.
1962 *Conchocele disjuncta*, Okutani p. 23, pl. 2, fig. 9.
1963a *Thyasira investigatoris*, Barnard p. 450.
1964 *Conchocele disjuncta*, Habe p. 181, pl. 56, fig. 15.

MATERIAL: *"John Murray" Expedition:* St. 59, South Arabian Coast, 22°22′48″N., 60°06′24″E.; depth: 1948 m; bottom: soft green mud; bottom temperature: 3·2°C; gear: triangular dredge. – 2 shells (in rather poor condition).

Th. Mortensen leg.: St. 7, Banda Sea, 5°38′30″S., 132°26′E.; depth: 196 m; bottom: clayish sand, stones; gear: Sigsbee trawl. – 1 shell.

DESCRIPTION: The shell is strongly inequilateral, the umbo (which is prominent and pointed) being placed at the anterior end of the shell. The anterior edge is concave, the dorsal edge convex. The ventral edge is roughly parallel to the dorsal edge and slightly convex. A broad lunule is delimited by a broad, rounded, irregular ridge. The area is long and narrow and sharply delimited. Lateral to the area there is a distinct furrow, running from the umbo to the postero-dorsal angle. A band, gradually becoming broader, runs from the umbo towards the postero-ventral angle and is delimited by two faint rounded ridges. The concentric sculpture is distinct and coarse, and becomes more pronounced towards the posterior end of the shell. The length of the ligament is about one-third of the length of the shell; the interior of each valve is glossy, with a fine radiating sculpture. The area and the dorsal furrow are seen internally as two distinct rounded ridges.

DIMENSIONS IN MM: Grant & Gale (1931) consider the maximum length to be 30 mm.

REMARKS: Conrad (1849) described *Venus bisecta* from Miocene deposits in Oregon. Smith (1895a) described and figured *C. investigatoris* from the Indian Ocean, "*Investigator*" St. 151. The present shells agree very well with the figures given by Alcock & Anderson (1897); in both figures and in the present specimens, the angle between the anterior and the dorsal edge is about 105°. Smith's figure (1895) shows a shell in which the corresponding angle is about 85°. Dall (1895, 1901) synonymized *V. bisecta* Conrad and *V. disjuncta* Gabb, the latter originally described from Pliocene deposits from

California. Dall, at the same time, recorded the species as being recent in the N.E. Pacific. Yabe and Nomura (1925) described fossil material from Japan which they assigned to *Thyasira bisecta*, and gave very good figures of the shell showing the great variation in its shape. These authors also considered *V. bisecta* and *V. disjuncta* as synonyms. Yabe & Nomura's fig. 9 shows a shell which is indistinguishable from the "*John Murray*" shells. Grant & Gale (1931) provided a complete list of the previous records of the species and held the opinion that *V. disjuncta* should by synonymized with *V. bisecta*. These authors also called attention to the extreme variation within this species and agreed with Yabe & Nomura's statement that the W. American and Japanese forms are conspecific. Besides occurring as a fossil in Japan it is also known from living specimens; Nakazima (1958) has described the soft parts. From the above review it appears quite certain that *C. disjuncta* is a synonym of *C. bisecta*, and that the species is known both as fossil and a recent species on both sides of the N. Pacific.

Apart from the shells listed above, the author has examined the material (one shell and some fragments) of the "*Valdivia*" *Expedition* (Thiele & Jaeckel 1931). It was found, without doubt, to be conspecific. By comparing the figures of *C. investigatoris* with those of *C. bisecta*, and comparing these figures with the available shell, the author is strongly inclined to consider *C. investigatoris* as also being synonymous with *C. bisecta*.

Distribution: In the N.E. Pacific the species is known from off Alaska to off Oregon (Dall, 1921). In the W. Pacific it is known from the Japan Sea and off S.E. Japan (Habe, 1958, 1961; Okutani, 1962) at depths ranging from 10–770 m. If the conclusion arrived at here is correct, i.e., that *C. investigatoris* is synonymous with *C. bisecta*, the distribution is extended to comprise also the S.E. Asian waters and the Indian Ocean. In addition, Barnard (1963) recorded the species from off S. Africa at depths of 1318–1464 m. The total vertical range of the species would be from 10–1948 m, but unfortunately, information concerning the presence of live specimens is very scanty. Nakazima does not indicate the depth at which his material was obtained. Barnard reported a specimen at the above-mentioned depth at a temperature of about 2·7°C.

Family **LUCINIDAE**

Lucina bengalensis E. A. Smith, 1894

Pl. 2, *fig.* 10.

1894 *Lucina bengalensis* E. A. Smith p. 171, pl. 5, figs. 1, 2.
1897 *Lucina bengalensis*, Alcock & Anderson pl. 2, fig. 4, 4a.
1902 *Lucina bengalensis*, Alcock p. 281.
1904 *Lucina bengalensis*, E. A. Smith p. 10.
1906 *Lucina bengalensis*, E. A. Smith p. 257.
1932a *Dentilucina* (*Dentilucina*) *bengalensis*, Prashad p. 162.
1940 *Phacoides bengalensis*, Winckworth p. 27.

Material: "*John Murray*" *Expedition:* St. 42, South Arabian coast, 17°26′N., 55°49′E.; depth: 1415 m; bottom: rock, mud; bottom temperature: 6·7°C; gear: triangular dredge. – 1 right valve.

Description: The valve is laterally compressed; it has a small umbo and a slightly arcuate postero-dorsal edge which is marked off from the nearly straight posterior edge by a rounded angle. The periostracum is brown. The lunule is very narrow, elongate and distinctly impressed. The sculpture consists of very fine distinct concentric ridges, close set near the umbo, but gradually becoming more widely spaced towards the periphery. Additionally, in the interstices between the ridges there is a finer, irregular striation which tends to become more distinct towards the periphery. Although the prodissoconch and hinge are badly worn, the presence of an anterior lateral tooth could be ascertained. The interior of the valve shows an indistinct radiating striation. The anterior adductor scar is elongate and narrow, the posterior one rounded, with an anterior ridge running towards the umbonal cavity. The pallial impression is distinct.

DIMENSIONS IN MM: The type measures 37 × 31.

REMARKS: The present valve is in rather bad condition. It does seem, however, to fit with Smith's (1894) description and figure of *L. bengalensis*.

DISTRIBUTION: Smith (1894) described the species from "*Investigator*" St. 131, Bay of Bengal, at 750 m depth. The presence of live specimens is not mentioned, but as one of the figures shows two united shells, it may be assumed that at least one living specimen was obtained. Smith (1904–1906) later recorded the species from "*Investigator*" St. 229, 232 and 261, all Laccadive Sea, at depths from 659–814 m, and from St. 323, Bay of Bengal, 847 m, but without indication of any live specimens. Prashad (1932a) recorded *L. bengalensis* from "*Siboga*" St. 17, Java Sea, 1060 m, but no mention is made of live specimens. In the collections of the U.S.N.M., Washington, D.C. the present author has seen a specimen (with remnants of soft parts) labelled "Bay of Bengal, 609 fms" (1114 m). Although it is not stated on the label it seems likely that the sample was collected by the "*Investigator*" *Expedition*. The only station of this depth is St. 173 (N.E. of Ceylon), although the species is not recorded from this station by Smith.

L. bengalensis is thus known from the Bay of Bengal and the S.E. Asian waters and live specimens from 750–1114 m. Temperature range: 6·7°–7·5°C.

Lucina inanis (Prashad, 1932)
Text fig. 19*D*; *pl.* 2, *figs.* 9, 11.

1932a *Dentilucina* (*Dentilucina*) *inanis* Prashad p. 162, pl. 5, figs. 9, 10.

MATERIAL: "*John Murray*" *Expedition:* St. 125, Zanzibar area, 5°36′12″N., 39°28′24″E.; depth: 805 m; bottom: light brown mud over grey clay; gear: modified Petersen grab. – 4 shells (one united pair).

DESCRIPTION: The shell is equivalve, rather compressed, the breadth (both valves) being equal to about 46% of the length. The antero-dorsal edge is concave and the postero-dorsal edge convex. The posterior end is straight and forms rounded edges with both the postero-dorsal edge and the ventral edge. Both lunule and area are deeply impressed, the latter being very narrow. The sculpture consists of very distinct concentric, laminate ridges. They are close set at the umbo, becoming farther apart towards the periphery, but the two or three nearest the margin are again more close-set. Dorsally, the concentric ridges become more prominent. On closer inspection it appears that the ridges nearest to the periphery are in fact almost completely closed tubes which have been formed by the distal curvature of the ridges. On the central and umbonal part of the shell the tubes are partly worn, leaving only the base. This is shown in fig. 19D (p. 283) giving a diagrammatic cross section of the valve. Apart from near the periphery, the tubes are partly preserved in the postero-dorsal part of the shell. A broad shallow depression runs from the umbo towards the anterior edge of the shell; in this region, which delimits a roughly triangular section of the shell, the concentric sculpture is less developed, but dorsal to the depression it becomes foliaceous. Besides the concentric sculpture already mentioned, there is a fine concentric striation covering the whole shell surface. The ligament is external and forms about 33% of the length of the shell. The concentric ridges are distinctly seen on the inner surface of the shell. The right valve has one small central hinge tooth. In addition, there is a small anterior lateral tooth, while the posterior lateral tooth is barely indicated. The left valve is devoid of teeth. The anterior adductor scar is elongate and about twice the size of the posterior adductor scar. The latter is ellipsoid with a dorsal and a ventral angle. A distinct groove runs from the anterior edge of the posterior adductor scar into the umbonal cavity and a similar groove, but less distinct, runs from the posterior limit of the anterior adductor scar. The whole inner surface has a fine radiating striation. The pallial impression is distinct and without a sinus.

DIMENSIONS IN MM: Present shell: 11·9 × 10·6 × 5·6.

REPRODUCTION: The prodissoconch is glossy and distinctly marked off from the teleoconch. It has a length of about 215 μ.

REMARKS: The present shells have been compared to Prashad's type material, which consists of four shells. Prashad's (1932a) description is very brief, and the two figures given are too poor to attempt safe identification. The present material was found to agree well with the shells of *D. inanis*.

DISTRIBUTION: Prashad described *D. inanis* from "*Siboga*" St. 312, Java Sea, depth: 217 m. The shells contained remnants of the dried up soft parts. Apart from the present material, no other record of the species exists. The two existing records show a bathymetrical range from 217–805 m, and a temperature range from about 7 to about 13·8°C.

Family **VENERIDAE**

Pitar sewelli n. sp.

Text fig. 20, *A*, *B*; *pl.* 2, *figs.* 5, 6.

MATERIAL: "*John Murray*" *Expedition:* St. 66, Gulf of Oman, 23°44′24″N., 58°40′E.; depth: 609 m; bottom: soft brown-green mud; bottom temperature: 12·3°C; gear: triangular dredge. – 27 shells. A shell, of one pair of united valves, much larger than the rest of the sample, has been selected as the holotype.

DIAGNOSIS: A species of the genus *Pitar* having a fine concentric sculpture, a very broad shallow pallial sinus and small adductor scars.

DESCRIPTION: *Type:* The shell is inequilateral, white and opaque. The postumbonal part forms about 66% of the length, the height is 88% and the breadth (both valves included), 60% of the length. Umbo rather prominent and rounded. The opisthodetic ligament is completely external, its length is about 20% of the length of the shell. The lunule is delimited by a fine line, appearing as a fine notch in the edge of the shell. The antero-dorsal edge is nearly straight from the umbo to the lunular notch. The postero-dorsal edge is curved. The concentric sculpture consists of a close set irregular striation which gradually becomes more distinct towards the periphery. The edge of the shell is smooth and has a fine groove running from the lunular notch to the region of the prodissoconch. The hinge of the right valve has three cardinal teeth of which the anterior and posterior ones are converging towards the umbo and connected *inter se*. The posterior tooth is bifid. The central cardinal is slightly curved and projects beyond the ventral edge of the hinge plate. In addition, there is an anterior lateral tooth located at about half the distance between the lunular notch and the anterior end of the ligament. The left valve has three dorsally-converging cardinal teeth of which the two anterior ones are united dorsally and form an angle of about 60°. The posterior cardinal tooth is located slightly ventral to the ligament, running almost parallel to it. An anterior lateral tooth is located at about half the distance between the lunular notch and the umbo. The interior of the shell is smooth. The pallial impression has a broad shallow sinus, anterior to which a faint straight groove runs towards the umbonal cavity. The adductor scars are indistinct, small and rounded.

Paratypes: The shells are all under 5 mm in length; some have been bored by a predatory mollusc, in several valves the ligament is preserved. They all agree in every detail with the type. In nearly all the paratypes the prodissoconch is preserved. It is distinctly marked off, yellowish-brown with a regular concentric sculpture. It has a length of 225–250 μ. In several right valves the anterior and posterior cardinal teeth are separate, indicating that the fusion observed in the type (and commonly found in venerids) is gradually established during growth.

DIMENSIONS IN MM: Holotype: 10·4 × 9·2 × 6·0.

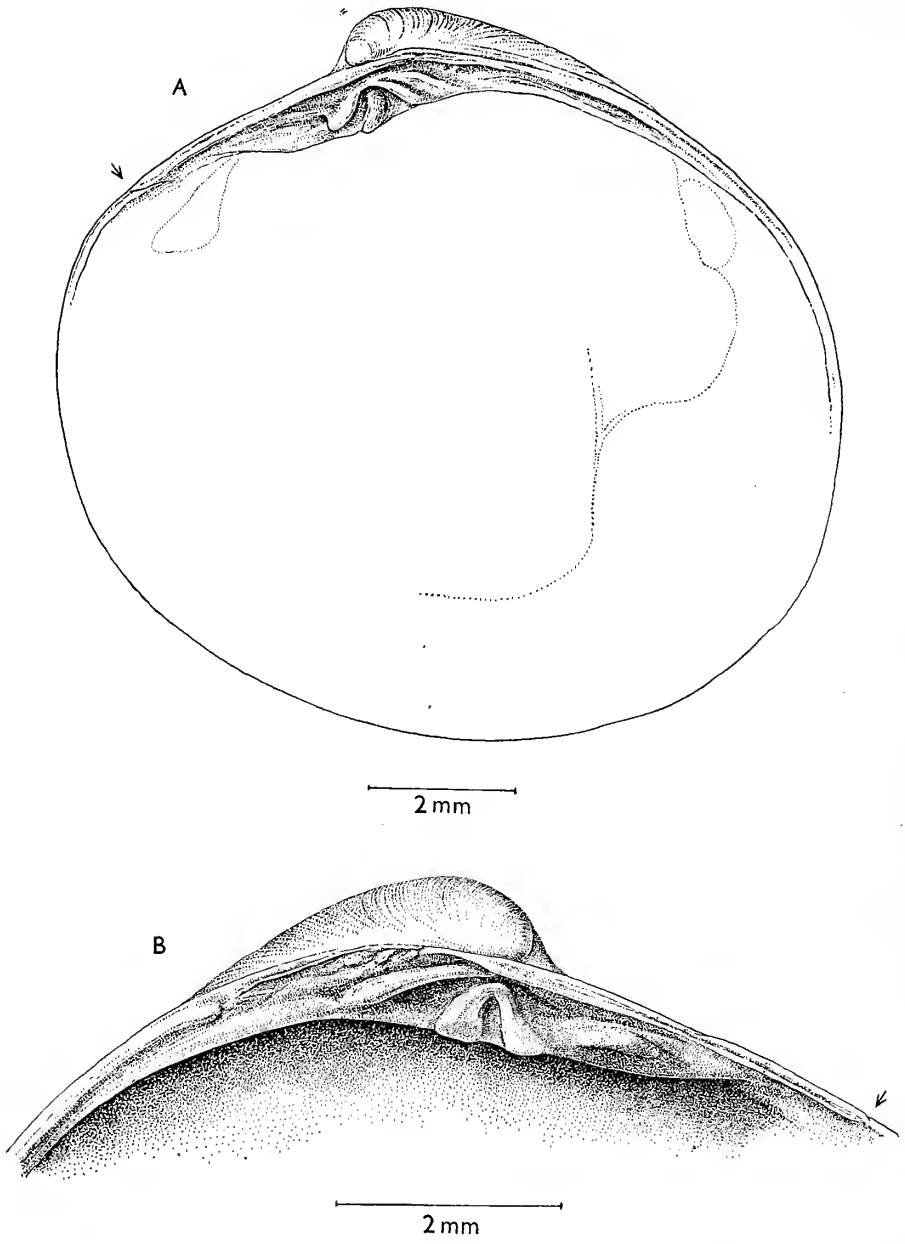


FIG. 20. *Pitar sewelli* n. sp., type; "*John Murray*" St. 66. (A) right valve, median view. (B) umbonal part of left valve. Lunular notch at ↓ P.H.W.

RELATIONSHIP: The present species seems to be closely related to *P. chordatum* (Roemer) recorded from off S.E. Japan at depths ranging from 10–100 m (Habe 1958). Habe figured the species (l. c. pl. 1, figs. 19, 20 and 1961, p. 129, pl. 58, fig. 1), and it appears that the two species have approximately the same general shape and sculpture. However, in *P. chordatum* the pallial sinus is deep, narrow and pointed while in *P. sewelli* it is broad and shallow. The adductor scars of *P. chordatum* are much larger than those of *P. sewelli*. The species is named for Dr. R. Seymour Sewell, the leader of the "*John Murray*" *Expedition*.

HOLOTYPE: B.M.(N.H.) Reg. No. 1966452.

PARATYPE: B.M.(N.H.) Reg. No. 1966453.

Venus juvenilis E. A. Smith, 1895
Pl. 2, figs. 12, 13, 14.

1895a *Venus juvenilis* E. A. Smith p. 9, pl. 2, fig. 2, 2a.
1897 *Venus juvenilis*, Alcock & Anderson pl. 4, fig. 4, 4a.
1940 *Venus (Timoclea) juvenilis*, Winckworth p. 27.

Material: *"John Murray" Expedition:* St. 177, Gulf of Aden, 12°01′54″N., 50°39′12″E.; depth: 274–366 m; bottom: green mud, rock; gear: Agassiz trawl. – 1 specimen (with dry soft parts), 20 shells.

St. 180, Gulf of Aden, 12°03′24″N., 50°40′12″E.; depth: 397 m; bottom: green mud, sand; gear: modified Petersen grab. – 3 specimens (with dry soft parts), about 600 shells.

Th. Mortensen leg.: St. 7, Bali Strait, 8°29′S., 114°40′E.; depth: 200 m; bottom: mud; gear: trawl. – 32 specimens, 6 shells.

Description: The shell is white and solid and has a prominent umbo. The smaller specimens are nearly oval in outline; in larger specimens the postero-ventral part protrudes as a rounded angle. The postero-dorsal edge is convex in lateral view. The sculpture is very distinct, consisting of broad radiating ribs. As the shell grows, secondary ribs are added in the interstices between the primary ones. The concentric sculpture consists of somewhat less distinct lamellose ridges which cross the radiating ribs. The lunule is relatively large and delimited by a deeply incised furrow. The whole edge of the shell, except along the ligament, is regularly crenulated. The prodissoconch has a length of 250–275 μ. The ligament forms about 20% of the total length of the shell. The hinge has three cardinal teeth; the interior of the shell is shiny. The anterior adductor scar is elongate with a dorsal angle and the posterior scar is somewhat larger and rounded, also with a dorsal angle. The pallial sinus is broad and shallow. *The soft parts:* the pedal opening is large and the mantle edge is provided with small unbranched, pointed tentacles which are regularly spaced, becoming somewhat larger close to the inhalant siphon. The inhalant siphon is short and stout, and the distal end is provided with 16–18 unbranched tentacles arranged in two concentric rows. The interior opening is provided with a ventral and a dorsal membranaceous valve. The dorsal valve is slightly extended dorsally, covering the ventral part of the exhalant opening. The latter has lateral valves, the opening between these appearing as a narrow longitudinal slit. This slit is partly covered by the distal part of the rectum, which is dorsally bilobed. The siphon retractors are well developed. The outer demibranch is much smaller than the inner and largely confined to the posterior half of the body. The labial palps are large. The foot is long and laterally compressed, with a posterior projection.

Dimensions in mm: Present shell: 12·3 × 10·9 × 8·0.

Reproduction: One of the specimens examined contained what appeared to be ripe eggs with a diameter ranging from 50–60 μ.

Remarks: The present material agrees well with the description of Smith (1895a) except on one point: in his paper the pallial sinus is described as "haud profundis". However, in Alcock & Anderson's otherwise very good figure (1897) the pallial impression is completely without a sinus. As already mentioned, a shallow pallial sinus has been observed in the present material.

Distribution: Smith reported *V. juvenilis* from "*Investigator*" St. 162, Bay of Bengal, depth: 265–458 m. One of Alcock & Anderson's figures (1897) shows a pair of united valves from this locality, indicating that live specimens were probably obtained. The present material shows that the species is distributed from the N.W. part of the Indian Ocean to S.E. Asian waters. The vertical range would seem to be from 200–397 (458) m. The known temperature range would seem to be from about 10–15·5°C.

Family **SEMELIDAE**

Abra profundorum (E. A. Smith, 1885)

Text fig. 21.

1885 *Semele* (*Abra*) *profundorum* E. A. Smith p. 88, pl. 5, fig. 5-5b.
1888 *Semele profundorum*, Pelseneer p. 16, pl. 2, fig. 6.
1889 *Syndesmya profundorum*, Dautzenberg p. 86.
1894 *Syndesmya maxima* Sowerby p. 40, pl. 5, fig. 5.
1894 *Abra maxima*, E. A. Smith p. 169, pl. 5, figs, 5, 6.
1895a *Abra maxima*, E. A. Smith p. 10.
1897 *Abra maxima*, Alcock & Anderson pl. 3, fig. 7, 7a.
1898 *Syndesmya profundorum*, Locard p. 226, pl. 12, figs. 36, 37.
1904 *Abra maxima*, E. A. Smith p. 11.
1906 *Abra maxima*, E. A. Smith p. 258.
1927 *Syndesmya profundorum*, Dautzenberg p. 334.
1931 *Abra maxima*, Thiele & Jaeckel p. 80.
1932a *Abra maxima*, Prashad p. 199.
1940 *Abra maxima*, Winckworth p. 27.
1962 *Abra maxima*, Clarke p. 67.
1962 *Abra profundorum*, Clarke p. 67.

MATERIAL: *"John Murray" Expedition:* St. 59, South Arabian coast, 22°22′48″N., 60°06′24″E.; depth: 1948 m; bottom: soft green mud; bottom temperature: 3·2°C; gear: triangular dredge. – 1 specimen.

St. 62, Northern Area of Arabian Sea, 22°53′30″N., 64°56′10″E.; depth: 1893 m; bottom: grey clay; bottom temperature: 4·0°C; gear: Agassiz trawl. – 1 specimen.

St. 108, Zanzibar area, 5°18′06″S., 39°24′12″E.; depth: 786 m; bottom: grey mud; bottom temperature: 7·9°C; gear: Agassiz trawl. – 3 shells.

St. 171, Central part of the Arabian Sea, 9°07′06″N., 55°27′06″E.; depth: 3840–3872 m; bottom temperature: 3·7°C; gear: Agassiz trawl. – 1 specimen.

St. 185, Gulf of Aden, 13°48′06″N., 49°16′48″E.; depth: 2000 m; bottom: green mud; gear: Agassiz trawl. – 2 specimens, 3 united pairs of shells.

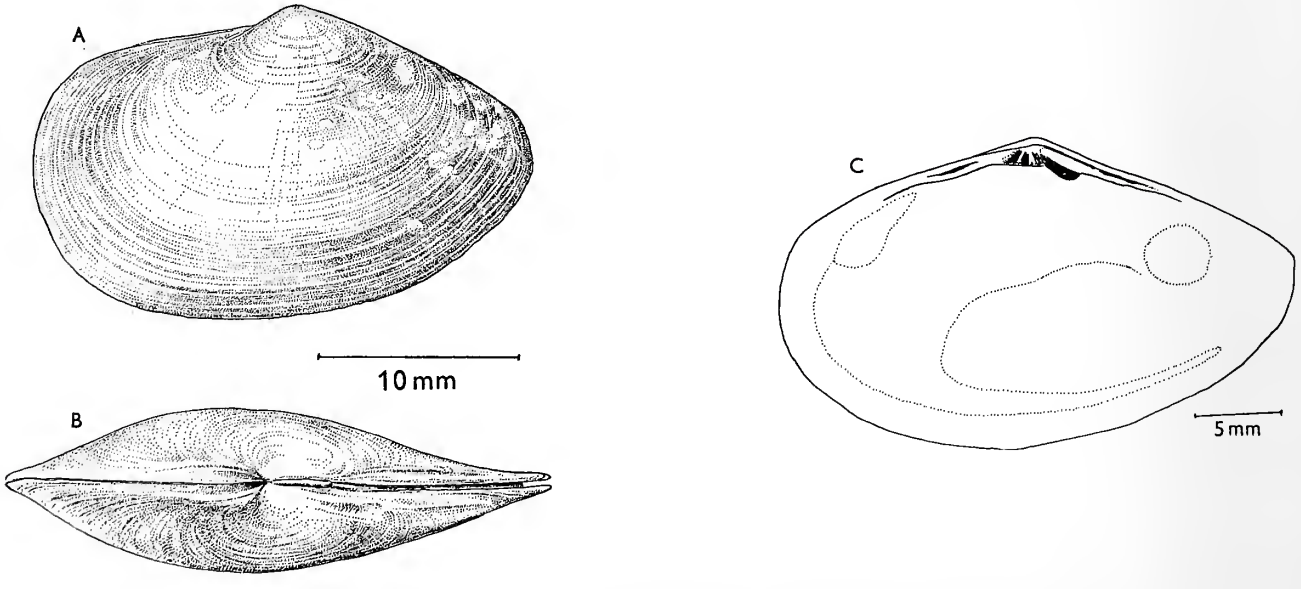


FIG. 21. *Abra profundorum* E. A. Smith; (A, B) *"Galathea"* St. 574, P.H.W.; (C) *"John Murray"* St. 59. (A) left valve, lateral view. (B) dorsal view. (C) interior of right valve.

DESCRIPTION: The valves are inequilateral, elongate, thin and laterally compressed. The post-umbonal part forms about 50% of the total length and the height equals about 60% of the length. The extreme posterior end is slightly curved towards the right, gaping distally. Seen in lateral view the

antero-dorsal edge is straight, the postero-dorsal edge straight or slightly convex and the two edges form an angle of about 140°. From the umbo a faint ridge runs in an anterior direction, separating an elongate and narrow lunule. Posterior to the umbo two fine ridges run towards the posterior edge. The ligament is distinct, opistodetic and forms from 8·5–12% of the total length of the shell. The sculpture consists of numerous, irregular fine ridges. The prodissoconch has a length of about 275 μ. The resilium is relatively large and elongate, the posterior end being the broader. The posterior cardinal tooth of the right valve is about twice the size of the anterior. The anterior adductor scar is elongate, pear-shaped, while the posterior adductor scar is rounded. The pallial sinus extends beyond the umbo and its maximum breadth is about half its length. The depth of the sinus, measured from the posterior edge of the shell to the anterior end of the sinus, has been examined in 12 shells and was found to form 65–82% of the total lengths of the shells. The interior of the shell shows a fine radiating structure. Many shells have a fine groove running from the anterior edge of the pallial sinus towards the umbo. In addition, another groove runs from the anterior edge of the posterior adductor scar towards the umbo. *The soft parts:* the gross anatomy corresponds very well to Pelseneers' figure (1888). The siphons are long and slender. The foot is relatively large and laterally compressed. The labial palps are large, about the size of or larger than the triangular gill.

Dimensions in mm: Present material: 29·3 × 17·2 × 7·0.

Reproduction: Apparently ripe eggs have a diameter of 55–65 μ.

Remarks: Based on material obtained by the "*Challenger*" *Expedition*, Smith (1885) described *Semele profundorum* from abyssal depths in the Atlantic and Pacific oceans. The present material agrees well with Smith's material, which has been examined by the present author. Sowerby (1894) described *Syndesmya maxima* from "*Investigator*" St. 133, Bay of Bengal, depth: 1240 m. His description is very brief and the figure is rather poor. However, Smith (1894) gave a more detailed description and a better illustration of *S. maxima*, and an excellent figure of the species was given by Alcock & Anderson (1897). The present author has examined the material from the "*Investigator*" referred to as *S. maxima* and also the "*Siboga*" material referred to that species by Prashad (1932a). A comparison of these samples with the numerous specimens and shells from the "*Galathea*" collections and the "*John Murray*" material indicated that they should all be referred to as one and the same species: *A. profundorum*. In the samples studied some variation was found in the shape of the shell; smaller specimens have a relatively larger height and a slightly more convex postero-dorsal edge (e.g., the type specimen). The shells referred to as *A. maxima* by Sowerby & Smith are larger specimens (about 35 mm long) and show a more elongate shape and a straight postero-dorsal edge. If the relative length of the pallial sinus of the type of *A. profundorum* is compared to that of *S. maxima*, it appears that in *A. profundorum* (Alcock & Anderson 1897) it forms 71% of the length, while in *S. maxima* it forms 80%. This variation is, however, smaller than the variation observed in the sample studied here. If the descriptions of *A. profundorum* and *S. maxima* are compared, it will be seen that they, to a large extent run parallel to one another. In his description of *A. profundorum* Smith mentions the presence of a faint groove running from the posterior end of the pallial sinus towards the umbo, and a similar groove from the anterior edge of the posterior adductor scar. These grooves have been observed in some specimens examined by the present author, while they are absent in others.

Distribution: Smith (1885) recorded *A. profundorum* from the following "*Challenger*" stations: 73, 85, 98, all in the eastern part of the C. Atlantic at depths from 1830–3203 m, and at St. 244, C. Pacific: depth: 5307 m. This material has been examined by the present author, who found that with the exception of St. 73, specimens alive at capture were found at all stations.

Sowerby & Smith recorded *A. maxima* from the following "*Investigator*" stations: 112, 133, 137, 222, 263, 265, 299, 301, 321 and 327, at depths ranging from 234–2378 m. The present author examined the extant material in the B.M.(N.H.) and discovered that specimens alive at capture were found at the following "*Investigator*" stations: 112, Bay of Bengal, 1027 m; 265, Bay of Bengal, 412–1087 m;

133, Bay of Bengal, 1241 m; 299, Arabian Sea, 2377 m; and 321, S. of Ceylon, 1208 m. Locard (1898) and Dautzenberg (1927) recorded *A. profundorum* from a number of localities in the C. and E. Atlantic at depths from about 1300–5413 m. The material has been studied by the present author. Thiele & Jaeckel (1931) mentioned shells only from a single "*Valdivia*" St. off Sumatra mentioned at 677 m depth. Prashad (1932a) recorded *A. maxima* from seven "*Siboga*" stations in the S.E. Asian sea. The material has been seen by the present author who found part of it to consist of rather worn shells, the identification of which may be doubtful. A single sample contained a specimen with dried up soft parts: St. 178, Ceram Sea, 835 m. It should finally be mentioned that the "*Galathea*" *Expedition* (unpublished) obtained *A. profundorum* at 16 stations (live specimens only considered) in the E. Atlantic, Indian Ocean, S.E. Asian sea and W. Pacific at depths from 990–4670 m.

From the above survey it appears that *A. profundorum* is widely distributed in the E. Atlantic, Indian Ocean and W. Pacific, while there seem to be no records from the W. Atlantic and the E. Pacific. The vertical range of the species would be from 835–5413 m, and the temperature range from about 0·7 to about 7·2°C.

Family **TELLINIDAE**

Tellina coromandelica Salisbury, 1934

Text fig. 22; pl. 2, figs. 17, 18.

1895a *Tellina parvula* E. A. Smith p. 10, pl. 2, fig. 3.
1896 *Tellina parvula*, Smith p. 375.
1897 *Tellina parvula*, Alcock & Anderson pl. 3, fig. 9, 9a.
1934 *Tellina coromandelica* Salisbury p. 86.
1940 *Tellina parvula*, Winckworth p. 28.

Material: "*John Murray*" *Expedition:* St. 77, S. Arabian Coast, 22°13′30″N., 59°52′E.; depth: 411 m; bottom: green mud, H_2S present; gear: modified Petersen grab. – 24 shells (one pair united).

Description: The shell is strongly laterally compressed, inequilateral; the height equals about 70–75% of the length. The umbo is moderately protruding. The antero-dorsal edge is slightly convex, while the postero-dorsal edge is nearly straight. The extreme posterior end is slightly turned to the right. The right valve has a sharp ridge running anteriorly from the umbo and a similar one running posteriorly, but the left valve has a much less distinct preumbonal ridge. Both valves have a rounded ridge which runs close to the dorsal edge. The two ridges extend somewhat beyond the lateral teeth. In addition, both valves have a distinct rounded edge running from the umbo to the postero-ventral corner. This ridge is rather indistinct in most of the worn shells of the present material. There is a distinct concentric sculpture consisting of irregular ridges. Between the rounded ridge already referred to and the postero-dorsal edge the concentric sculpture becomes more distinct. The ligament forms 17–20% of the total length of the shell, and the postumbonal part from 36–44%. The prodissoconch is 220–240 μ long. The cardinal teeth are small. The adductor scars are pear-shaped, the anterior somewhat larger than the posterior. The pallial sinus is deep. Its length (measured from the posterior edge of the shell to the anterior edge of the sinus) equals 79–83% of the length of the shell. The posterior opening of the sinus is narrow.

Dimensions in mm: Present material: 19·2 × 13·4 × 6·1.

Remarks: This species was described by Smith (1895) from material obtained by the "*Investigator*". The present shells agree in all details with Smith's description and the good figure given by Alcock & Anderson (1897). Salisbury (1934) discovered that the specific name given by Smith, was preoccupied, and proposed the name *coromandelica* for the species.

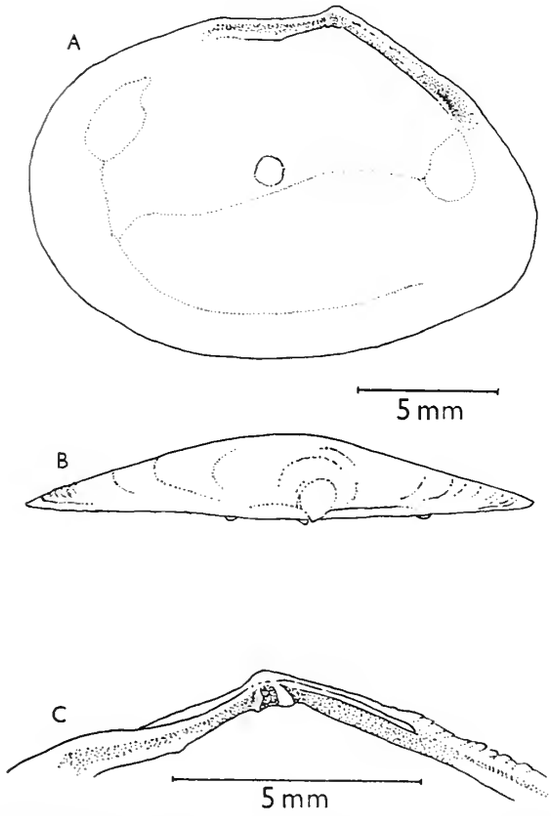


FIG. 22. *Tellina coromandelica* Salisbury; "*John Murray*" St. 77. (A) interior of right valve. (B) dorsal view of right valve. (C) hinge of right valve.

DISTRIBUTION: Smith (1895, 1896) recorded the species from the following "*Investigator*" stations: St. 2, off S.W. coast of Ceylon, depth: 1235 m; 166, Bay of Bengal, depth: 243 m; 176, Laccadive Sea, depth: 1958 m. Unfortunately, Smith does not give any information about the presence of live specimens.

Tellina travancorica E. A. Smith, 1899

Text fig. 23; pl. 2, figs. 15, 16.

1899 *Tellina travancorica* E. A. Smith p. 249.
1901 *Tellina travancorica*, Alcock & McArdle pl. 13, fig. 1, 1a.
1904 *Tellina travancorica*, E. A. Smith p. 11.
1906 *Tellina travancorica*, E. A. Smith p. 259.
1940 *Tellina travancorica*, Winckworth p. 28.

MATERIAL: "*John Murray*" *Expedition:* St. 180, Gulf of Aden, 12°03′24″N., 50°40′12″E.; depth: 397 m; bottom: grey mud, sand; gear: modified Petersen grab. – 1 right valve.

Th. Mortensen leg.: St. 52, Banda Sea, 5°46′S., 132°49′35″E.; depth: 352 m; bottom: mud; gear: trawl. – 1 left valve.

DESCRIPTION: The shell is elongate, the height being about 66% of the length, laterally compressed and equilateral; thin and semi-transparent. The umbo is relatively small and pointed; the dorsal edges almost straight and forming an angle of about 120°. The posterior end of the shell is slightly recurved. The sculpture consists of numerous sharply raised concentric ridges; near the umbo there are eight to nine ridges per mm and at the periphery about five ridges per mm. Posteriorly, the ridges

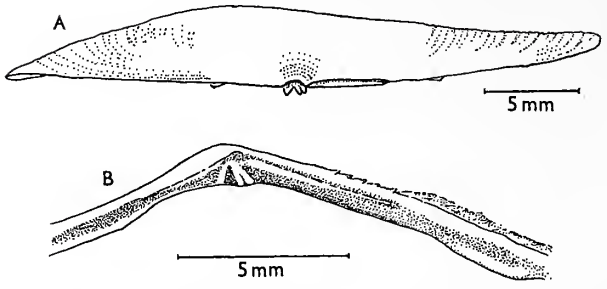


FIG. 23. *Tellina travancorica* E. A. Smith; "*John Murray*" St. 180. (A) dorsal view of right valve. (B) enlarged portion of hinge-line of right valve.

become more irregular and foliated after having crossed a rounded angle running from the umbo to the posterior end of the shell. The hinge forms 16% of the total length of the shell. The cardinal teeth are small. The anterior adductor scar is elongate and narrow, while the posterior is rounded. The pallial sinus is deep, its length, measured from the posterior edge of the shell to the anterior edge of the sinus, is 75% of the length of the shell. The posterior opening of the sinus is narrow, and the antero-dorsal limit almost straight, running nearly parallel to the antero-dorsal edge of the shell.

DIMENSIONS IN MM: The shell figured by Alcock & McArdle (1901) measures 44 × 25.

REMARKS: The species was described, but not figured, by Smith in 1899. A fine figure of both the external and internal side of the shell was given by Alcock & McArdle (1901). The present shells agree in all details with Smith's description and the figure referred to.

DISTRIBUTION: The species is reported from the following "*Investigator*" stations: 229, off Laccadive Sea, depth: 659 m; 259, Laccadive Sea, depth: 540–659 m; 337, Laccadive Sea, depth: 496 m. There is no indication as to whether living specimens were obtained. Vertical range: 352–659 m.

Family **PHOLADIDAE**

Xylophaga murrayi n. sp.

Text fig. 24.

MATERIAL: "*John Murray*" *Expedition:* St. 110, Zanzibar area, 5°03′42″S., 39°15′24″E.; depth: 347–384 m; bottom: grey-green mud, sand; bottom temperature: 12·9°C (at 320 m depth); gear: otter trawl. – 1 specimen, in rather poor condition.

DIAGNOSIS: A species of *Xylophaga* with a mesoplax consisting of two triangular plates forming a pointed angle, and a short siphon having about 35 terminal tentacles.

DESCRIPTION: The shell is rather small for the genus. The umbo is prominent and relatively large, and the beak relatively small, extending less than one-third the distance to the ventral edge of the shell. The beak has nine ridges. The spaces between the ridges are two to three times the breadth of the ridge. The mesoplax consists of two triangular plates, which have short median edges. In frontal view the two plates form a pointed angle, and their dorsal surface has a fine striation running from the median edge towards the lateral angle. The umbonal-ventral sulcus is shallow, and has a distinct central groove. Posterior to the sulcus is a faint rounded ridge running from the umbo to the ventral edge. The posterior slope has a fine irregular concentric striation, which tends to become somewhat foliaceous towards the postero-ventral part of the shell. Owing to the fragility of the specimen the two valves could not be separated, and accordingly, the umbo and the interior of the

shell could not be studied. *The soft parts:* the siphon is about 1 mm long and does not extend beyond the posterior edge of the shell. The two openings are close together. A circle of about 35 short tentacles surrounds both openings. The incurrent opening is wide and has its own circle of about 15 very small, rounded tentacles. The excurrent opening is located in a triangular, depressed area.

Dimensions in mm: 5·0 × 5·6 × 5·7.

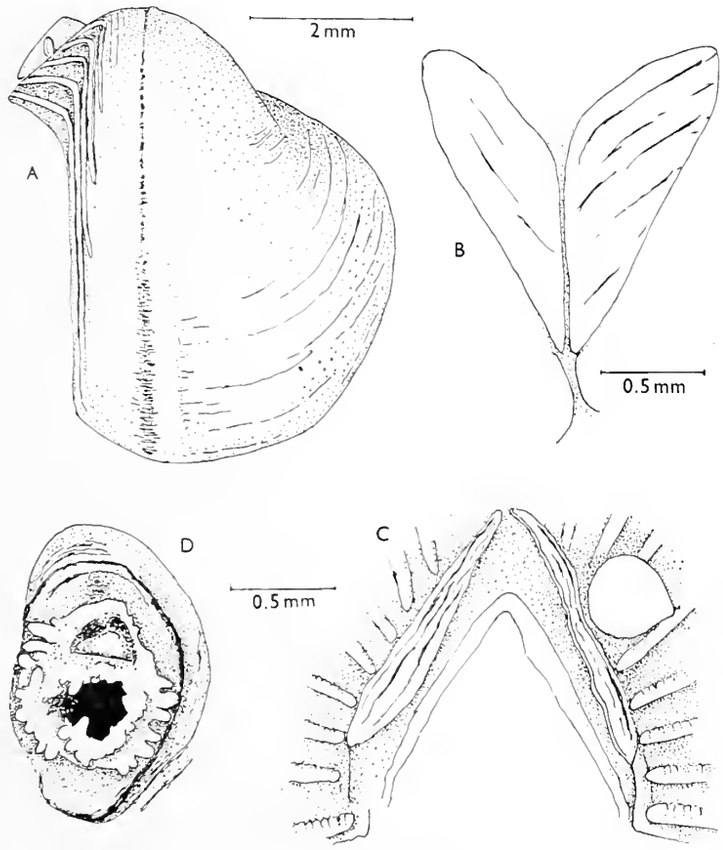


Fig. 24. *Xylophaga murrayi* n. sp., type; "*John Murray*" St. 110. (A) left valve, lateral view. (B) dorsal view of mesoplax. (C) frontal of view mesoplax. (D) siphon, posterior view.

Reproduction: Three embryos were found attached to the shell: two of them were fixed to the mesoplax, while the third was fixed immediately posterior to the umbo. The embryos are rounded, with a very prominent umbo. The embryo had a length of about 330 μ.

Relationship: The present species would seem to be related to *X. wolffi* Knudsen, described from the Sulu Sea, 5050 m depth (Knudsen, 1961). This species has a similar mesoplax, consisting of two triangular plates which form an angle when viewed from the front. In addition, this species also has a very short siphon, which, however, differs from the siphon of *X. murrayi* in several respects. In *X. wolffi* the two openings are more widely separated and the common circle of tentacles found in *X. murrayi* is absent. *X. wolffi* has, in addition, a relatively much larger beak than *X. murrayi*, and has much denser ribs. Only one species of *Xylophaga* has been previously described from the Indian Ocean, viz., *X. indica* Smith, obtained at "*Investigator*" St. 233, off the Andaman Is., 339 m depth. This species has also been studied by the present author (Knudsen, 1961), and was found to have a completely different mesoplax from that of *X. murrayi*.

The species is named for Sir John Murray.

Type: B.M.(N.H.) Reg. No. 196643 W.

Family **MYOCHAMIDAE**

Myodora quadrata E. A. Smith, 1899

Text fig. 25; pl. 2, figs. 19, 20.

1899 *Myodora quadrata* E. A. Smith p. 250.
1901 *Myodora quadrata*, Alcock & McArdle pl. 13, fig. 5, 5a.
1904 *Myodora quadrata*, E. A. Smith p. 9.
1932 *Myodora quadrata*, Thiele & Jaeckel p. 85.
1931 *Myodora valdiviae* Thiele & Jaeckel p. 85, pl. 4, fig. 121.
1940 *Myodora quadrata*, Winckworth p. 28.
1950 *Myodora teramachii* Habe p. 26, pl. 4, figs. 14-16.

MATERIAL: *"John Murray" Expedition:* St. 176, Gulf of Aden, 12°04′06″N., 50°38′36″E.; depth: 655–732 m; bottom: green mud, sand; gear: Agassiz trawl. – 16 shells.

Th. Mortensen leg.: St. 51, Banda Sea, 5°46′30″S., 132°51′E.; depth: 348 m; bottom: mud; gear: trawl. – 1 specimen.

DESCRIPTION: The species is solid, strongly laterally compressed, inequivalve and inequilateral. The right valve is convex and much larger than the left, which is flat; in the right valve the umbo is prominent and strongly curved. In profile the anterior and dorsal edges are nearly straight, and form an approximate right angle. The posterior end is regularly curved. The margin from the umbo to the postero-ventral edge is rounded. Posterior to the umbo a distinct area is delimited by a prominent rounded edge. The sculpture consists of concentric, somewhat irregular and sometimes lamellose ridges which become more close set towards the periphery. In addition, there is a fine radiating sculpture. The resilial pit is small, deep and triangular. The hinge is devoid of teeth, but both anterior and posterior to the umbo is a distinct furrow running parallel to the edges of the shell. The dorsal edge of the left valve is inserted into this pit, and the inner surface of the shell is nacreous. The adductor scars are relatively small, the anterior elongate, the posterior rounded. The pallial sinus is very broad and shallow. The left valve is flat, and considerably smaller than the right and has a more pointed, slightly reflected umbo. The anterior and dorsal parts of the shell are sharply bent at right angles to the rest of the shell to form two prominent ridges, of which the anterior is straight and the posterior slightly concave. The concentric sculpture is similar to that of the right valve but is less prominent. The hinge is devoid of teeth. The inner surface is similar to that of the right valve. The prodissoconch has a length of 190–215 μ.

DIMENSIONS IN MM: Thiele & Jaeckel (1931) state that *M. valdiviae* measures 13 × 10. The largest shell of the present collection is 11·3 × 8·8.

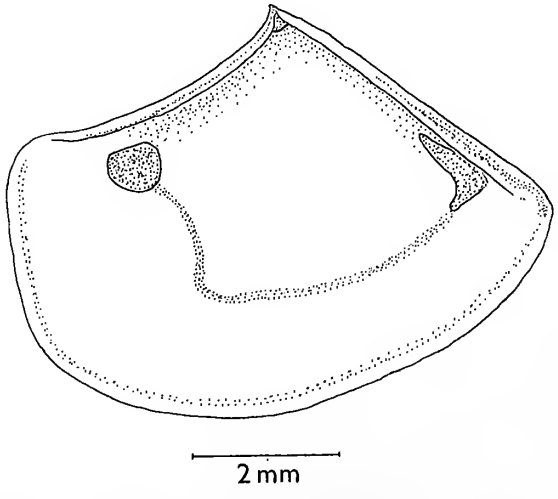


FIG. 25. *Myodora quadrata* E. A. Smith; *"Valdivia"* St. 245. Interior of left valve.

Remarks: Smith (1899) described the species on right valves only and Alcock & McArdle (1901), gave a fine figure of a shell. The present shells agree very well with Smith's species. Thiele & Jaeckel (1932) recorded Smith's species and in addition described a new one, *M. valdivae*, but they did not point out the relation of this new species to *M. quadrata*. They did point out, however, that *M. valdivae* is somewhat variable as to shape, juvenile shells being more triangular. The present author has examined the "*Valdivia*" material assigned to *M. quadrata* and *M. valdivae*. A careful comparison of these two samples with the present material gave the result that they were undoubtedly conspecific. Thus, *M. valdivae* should be regarded as a synonym of *M. quadrata* only. Habe (1950) described and figured *M. teramachii* from off S.E. Japan. In the description it is noted that the species closely resembles *M. quadrata*, but can easily be distinguished from this by its more elongate shape and by the less prominent umbo. Judging from the good description and figures it would appear that Habe's species should rather be considered synonymous with *M. quadrata*. The differences in shape noted by Habe would seem to fall within the range of variation observed in the shells seen by the present author.

Distribution: Smith recorded the species from both the Arabian Sea and the Bay of Bengal ("*Investigator*" St. 229, 233) at depths of 100 and 350 m, but only right valves were found. Thiele & Jaeckel recorded the species from off E. Africa ("*Valdivia*" St. 242, 245, 256) and off Sumatra (St. 191). The present author found that specimens with dry soft parts were present at stations 242, 245 and 191 at depths ranging from 404–750 m. Habe recorded *M. teramachii* from S.E. Japan and gives the depth 62 m, but gave no information about the presence of live specimens. From the survey given it appears that the species has a horizontal distribution, ranging from off E. Africa to S.E. Japan, and that the known vertical distribution of live specimens is from 348–750 m. The temperature range would be from about 7·3 to about 11 °C.

Family **VERTICORDIIDAE**

Lyonsiella murrayi n. sp.

Text figs. 26, 27.

Material: "*John Murray*" *Expedition:* St. 119, Zanzibar area, 6°29′24″S., 39°49′54″E.; depth: 1207–1463 m; bottom temperature: 6·2 °C; gear: Agassiz trawl. – 1 specimen.

Diagnosis: A *Lyonsiella* with about 31 radiating lines on the shell and branched tentacles around the branchial opening.

Description: The shell is thin and semi-transparent, slightly inequivalve, the left valve slightly larger than the right, and somewhat inequilateral. The umbo is low, rounded, and strongly incurved. In lateral view the antero-dorsal edge is nearly straight; the postero-dorsal edge curved. The anterior part of the ventral edge is nearly straight. In dorsal view the shell is somewhat inflated in the middle; the anterior and posterior edges are straight. The radiating sculpture consists of about 31 fine grooves, which are fairly regularly spaced; a fine, irregular, concentric striation is also present. The prodissoconch is eroded. Both valves are without hinge teeth, but the left has a callus located ventral to the umbo. The ligament is opisthodetic. The adductor scars are small and indistinct; the anterior is rhomboid and located at the anterior limit of the umbonal cavity; the posterior scar is circular and located close to the posterior end of the ligament. The lithodesma has two posterior projections, the left one being the larger; the anterior end is irregular. *The soft parts:* the mantle has three openings. The middle fold is provided with regularly spaced globular projections, which are found all along the mantle, although gradually becoming smaller and more distant towards the anterior end. The pedal opening is a simple slit with somewhat thickened edges. The branchial opening has a row of well-developed branched tentacles, which are laterally compressed; the branches (generally 10–12) are

anterior and posterior. At irregular intervals, short, simple and rounded tentacles are found in some of the interstices between the branched tentacles; the inner fold forms a short velum. The excurrent opening is a relatively small slit with thickened edges, but a real siphonal tube is not present. Between the posterior edge of the branchial opening and the excurrent opening, two lateral pointed tentacles are present, and dorsal to the excurrent opening are three smaller pointed tentacles. The foot is well developed, cylindrical, with abyssal slit, but no byssus. The dorsal labial palps are small and pointed, the ventral pair reaching to the base of the foot.

Dimensions in mm: 12·1 × 12·8 × 7·5.

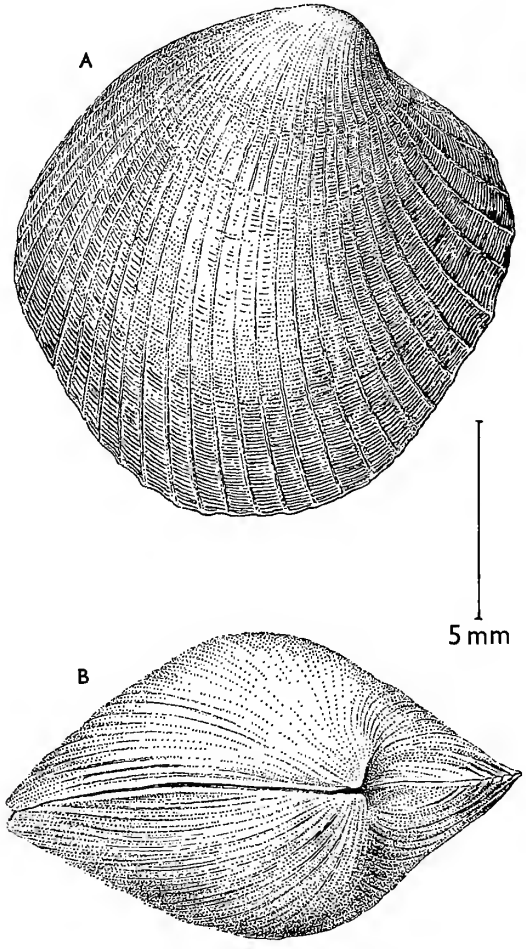


Fig. 26. *Lyonsiella murrayi* n. sp., type; "*John Murray*" St. 119. (A) lateral view of right valve. (B) dorsal view. P.H.W.

Reproduction: The species is hermaphrodite. The female gonad contains what appear to be ripe eggs with diameters of 120–150 μ.

Food: The stomach contains a small amount of tiny crustaceans (unidentified) with no admixture of debris.

Remarks: The present species would seem to differ from all species of *Lyonsiella* in which the soft parts have been studied. Pelseneer (1888) studied *Lyonsiella jeffreysi* and *L. papyracea*, both described by Smith (1885). On comparing Smith's descriptions and figures of these two species it is clear that *L. jeffreysi*, which has been reported from the C. Atlantic ("*Challenger*" St. 106) at a depth of about 3383 m, has a differently shaped shell with a pronounced angle between the antero-dorsal and the ventral edge. Pelseneer's (l. c.) figure (pl. 2, fig. 7) of the anatomy shows that the branchial opening is provided with simple, undivided tentacles and that the excurrent opening appears as a

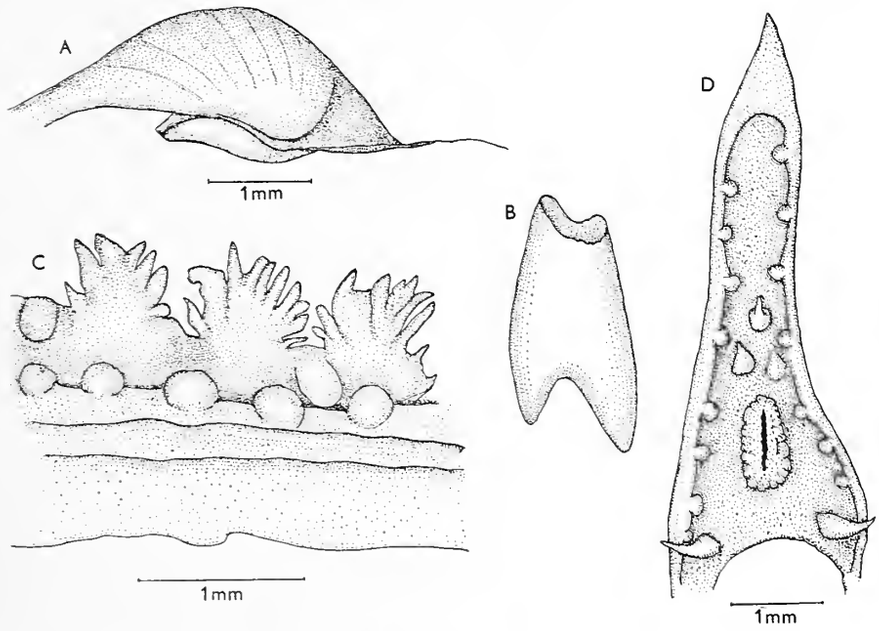


FIG. 27. *Lyonsiella murrayi* n. sp., type; "*John Murray*" St. 119. (A) umbonal part of left valve and lithodesma *in situ*. (B) lithodesma, ventral view, posterior end below. (C) the mantle edge at the branchial opening showing the branched and nodulose tentacles. (D) posterior part of the mantle showing the excurrent opening and the papillae surrounding it, incurrent opening below.

short tube. The shell of *L. papyracea* (Smith, 1885 p. 73, pl. 25, fig. 2–2b) is similar to that of *L. murrayi*. *L. papyracea*, recorded from the southern part of the Indian Ocean ("*Challenger*" St. 157) at a depth of 3566 m has a shell very similar in shape to that of the present species; the number of radiating lines is stated to be about 40. Pelseneer's figure of the anatomy (pl. 2, fig. 8) shows that, as in *L. jeffreysi*, the tentacles at the branchial opening are undivided (although they differ in shape from those of *L. jeffreysi*); in addition, *L. papyracea* has large anterior labial palps, and a small second pair,while in *L. murrayi* these conditions are reversed. Pelseneer (1911) described and figured the anatomy of two more species of *Lyonsiella*, viz., *abscissa* and *pilula*, both based on material from the "*Siboga*" *Expedition*. The former is not recorded in Prashad's account of the "*Siboga*" bivalvia, and Pelseneer did not give any information about the origin of his material; Prashad, however, described and figured *L. pilula* from "*Siboga*" St. 88, depth: 1301 m. Pelseneer's figures show that in *L. abscissa* the tentacles of the branchial opening are relatively very large, undivided and pointed, and the excurrent opening forms a short tube. Unfortunately, Pelseneer does not give a figure showing the tentacles of the branchial opening in *L. pilula*, but the only figure given does show conditions of the labial palps and of the excurrent opening (which differ markedly from that of *L. murrayi*). I have examined the type of *L. pilula*, a specimen with dry soft parts, from "*Siboga*" St. 88, S.E. Asian waters, depth: 1301 m. It differs from *L. murrayi* in having a more pronounced anterior angle, a nearly straight postero-dorsal edge and by being much more inflated. Okutani (1962), described and figured two new species of *Lyonsiella*, viz., *parva* and *media*, both from bathyal depths off S.E. Japan. Both of these would seem to differ in shape from *L. murrayi*.

The species is named for Sir John Murray.

TYPE: B.M.(N.H.) Reg. No. 196644 W.

Euciroa crassa Thiele & Jaeckel, 1931

Text fig. 28A; pl. 3, fig. 3.

1931 *Euciroa crassa* Thiele & Jaeckel p. 90, pl. 5, fig. 30.
1952 *Euciroa cistagemma* Kuroda p. 14, pl. 1, figs. 16-18.
1958a *Euciroa cistagemma*, Habe p. 277, pl. 13, fig. 9.
1961 *Euciroa cistagemma*, Habe p. 145, pl. 65, fig. 8.
1964 *Euciroa cistagemma*, Habe p. 213, pl. 65, fig. 8.

MATERIAL: *"John Murray" Expedition:* St. 159, Maldive area, 4°47′30″N., 72°45′18″E.; depth: 914–1463 m; gear: Monégasque trawl. – 1 valve (right).

DESCRIPTION: The shell is thick with a prominent umbo, inequilateral, the postumbonal part forming about 40% of the length. The antero-dorsal edge is slightly concave anterior to the umbo, but is otherwise slightly convex. The postero-dorsal edge is convex, and the two edges form an angle of about 110°. A lunule is distinctly delimited by a groove extending from the umbo to a little further than the dorsal limit of the anterior adductor scar. The area is more elongate and narrow than the lunule, and is delimited by a very faint groove extending from the umbo to slightly further than the dorsal corner of the posterior adductor scar. The sculpture consists of about 40 radiating, irregularly spaced ridges provided with pointed close-set nodules. The ribs are more close set on the posterior half of the shell. The interspaces between the ridges are provided with numerous irregularly arranged nodules, which are much smaller than those of the ridges proper. In addition to the radiating sculpture, the peripheral part of the shell has a fine concentric sculpture, giving a wrinkled appearance. Two faint, broad grooves run from the umbo towards the postero-ventral edge of the shell. The cardinal tooth of the hinge is large. Both adductor scars are rounded and angular dorsally, the anterior being somewhat larger than the posterior. The elongate siphonal retractor scar is not distinctly separated from the adductor scar. The interior surface of the shell is nacreous. The ventral half has numerous irregular radiating ridges, and the ventral edge has numerous close set sharp folds.

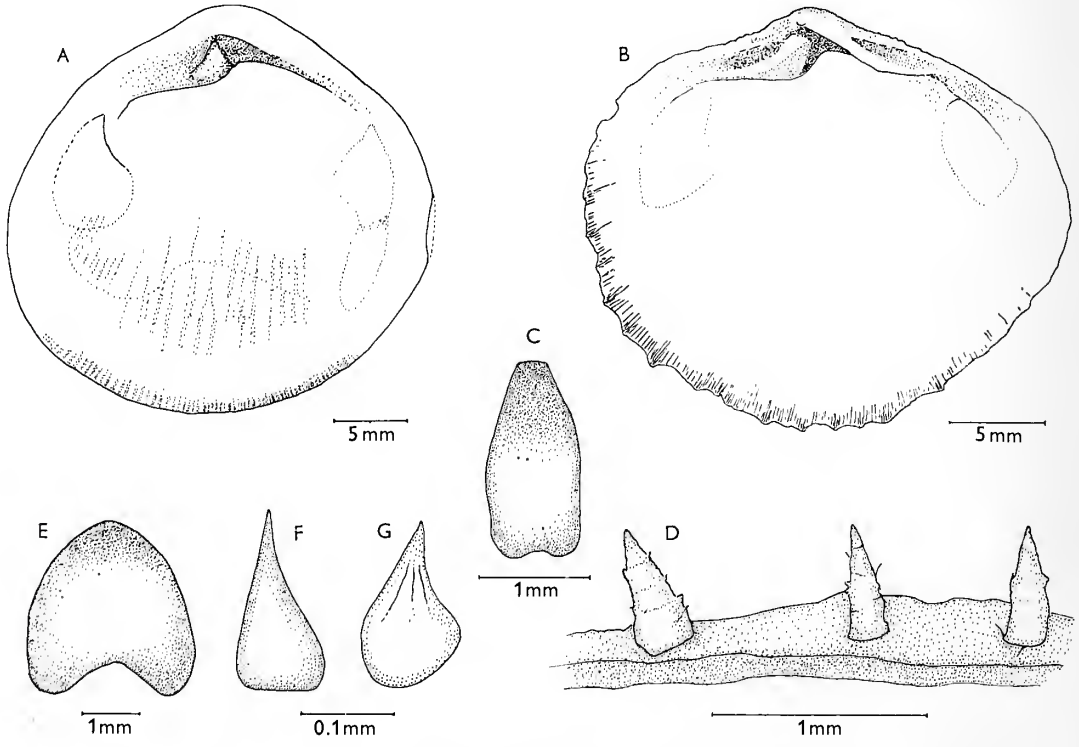


FIG. 28. (A) *Euciroa crassa* Thiele & Jaeckel; *"John Murray"* St. 159. Interior of right valve. (B–D) *Euciroa eburnea* (Wood-Mason & Alcock); *"Galathea"* St. 302. (B) interior of right valve. (C) lithodesma, ventral view, posterior end below. (D) calcareous spines of the periostracum of the mantle edge. (E–G) *Euciroa rostrata* Thiele & Jaeckel; *Th. Mortensen* St. 62. (E) lithodesma, ventral view, posterior end below. (F, G) calcareous spines of the periostracum of the mantle edge.

Dimensions in mm: Thiele & Jaeckel (1931): 38 × 33.

Remarks: The present shell agrees rather well with the description given by Thiele & Jaeckel, who note that the range of variation in the shape of the shell is considerable; the present shell is, however, very close to their figure. The authors also noted great variation in the sculpture. In some valves the radiating ridges are well developed and continuous, but in others, the ribs are reduced to rows of nodules or short spines. *Euciroa pacifica* Dall (1895) is a closely related species which may prove to be conspecific with the present one. It differs in having a somewhat more angular antero-dorsal edge and in being slightly more inflated. Small differences are also found in the shape of the adductor scars. *E. pacifica* agrees with *E. crassa* in having the same sculpture and in the presence of radiating ridges on the ventral half of the internal surface and sharp folds at the ventral edge. Kuroda (1952) described and figured *E. cistagemma* which is stated to be very similar to *E. crassa*, but has a broader posterior part in which the radiating ribs are close set, and does not have an obtuse postero-ventral angle. The present shell has an obtuse postero-ventral angle and a posterior area with close set ribs, and thus seems to unite the distinguishing characters of *E. crassa* and *E. cistagemma*. The hinge seems to be similar to that of *E. cistagemma*. Considering the variability in *E. crassa* noted by Thiele & Jaeckel the present author is inclined to consider *E. cistagemma* a synonym of *E. crassa*.

Distribution: Thiele & Jaeckel recorded the species from the "*Valdivia*" *Expedition* St. 246, off E. Africa at 818 m depth. Kuroda recorded *E. cistagemma* from off S.E. Japan, depth about 183 m. Kuroda does not mention the presence of live specimens, but as the lithodesma is figured, live specimens were probably present. Habe (1958) recorded the species from off S.W. Japan at depths between 200–300 m, but no indication of live specimens was given.

Euciroa eburnea (Wood-Mason & Alcock, 1891)

Text figs. 28 *B–D*, 29; *pl.* 3, *figs.* 6, 7.

1891b *Verticordia* (*Euciroa*) *eburnea* Wood-Mason & Alcock p. 447, figs. 14a-d.
1894 *Verticordia optima* Sowerby p. 39, pl. 5, fig. 3.
1897 *Verticordia* (*Euciroa*) *eburnea*, Alcock & Anderson pl. 4, figs. 1, 1a-e.
1904 *Euciroa eburnea*, E. A. Smith p. 8.
1931 *Euciroa eburnea*, Thiele & Jaeckel p. 89, pl. 5, fig. 128.
1940 *Euciroa eburnea*, Winckworth p. 28.

Material: "*John Murray*" *Expedition:* St. 119, Zanzibar area, 6°29′24″S., 39°49′54″E.; depth: 1207–1463 m; bottom temperature: 6·2°C; gear: Agassiz trawl. – 1 pair of united valves containing remnants of soft parts.

St. 122, Zanzibar area, 5°21′24″S., 39°23′E.; depth: 732 m; bottom: grey-green mud; bottom temperature: 8·3°C; gear: otter trawl. – 5 shells, fragmented.

St. 143, Maldive area, 5°15′48″S., 73°22′48″E.; depth: 797 m; bottom: grey sand; bottom temperature: 7·9°C; gear: Agassiz trawl. – 7 shells.

St. 176, Gulf of Aden, 12°04′06″N., 50°38′36″E.; depth: 655–732 m; bottom: green mud, sand; gear: Agassiz trawl. – 2 fragments.

"*Galathea*" *Expedition:* St. 202, off Natal, S. Africa, 25°20′S., 35°17′E.; depth: 575–595 m; bottom: sand; gear: sledge trawl, dredge. – 4 specimens, 9 shells.

St. 443, Mindanao Sea, 8°48′N., 124°09′E.; depth: 1500 m; bottom: mud, many fragments of plants; gear: sledge trawl, dredges. – 1 large fragment.

Description: The shell is oval in outline with a low rounded umbo and is slightly inequivalve. The postumbonal part forms about 60% of the total length. A small but deeply impressed lunule is present. The sculpture consists of radiating rows of small pointed spines and, in addition, the whole

surface is covered by microscopic nodules. On the posterior part of the shell one radiating row of spines is more prominent than the remaining rows; posterior to this, the spines are not arranged in radiating rows but dispersed all over the surface of the shell. The prodissoconch has a length of about 350 μ. The resilium is a deep triangular pit. Anterior to this the right valve has a very prominent rounded tooth, which fits into a triangular pit of the left valve. The latter has a well-developed lobe anterior to the umbo and extending below the corresponding part of the right valve. The interior surface is nacreous. The adductor scars are large and rounded, the anterior being somewhat larger than the posterior. The ventral edge of the shell is finely serrated. The lithodesma is long and narrow with two faintly developed posterior lobes. *The soft parts:* the muscular part of the mantle is distinctly marked off. The periostracum of the mantle edge is provided with pointed calcareous spines, located at regular intervals along the whole edge. The spines are based inside the outer edge of the lobe and are provided with small secondary spines. Sand grains, small fragments of shells and Foraminifera were found adhering to the posterior part of the mantle edge and the siphon. The siphon is short. The incurrent opening is surrounded by about 25 finger-like tentacles arranged in one row. The excurrent opening has about 14 similar tentacles, of which about half are situated dorsally, the rest lateral to the opening.

DIMENSIONS IN MM: "*John Murray*" St. 119: 39·8 × 34·0 × 23·5. The fragment from "*Galathea*" St. 443 probably had a length of about 45 mm.

REPRODUCTION: All four specimens, measuring 12–28 mm in total length, were immature.

FOOD: Two specimens contained a few forams, and in one a copepod was found.

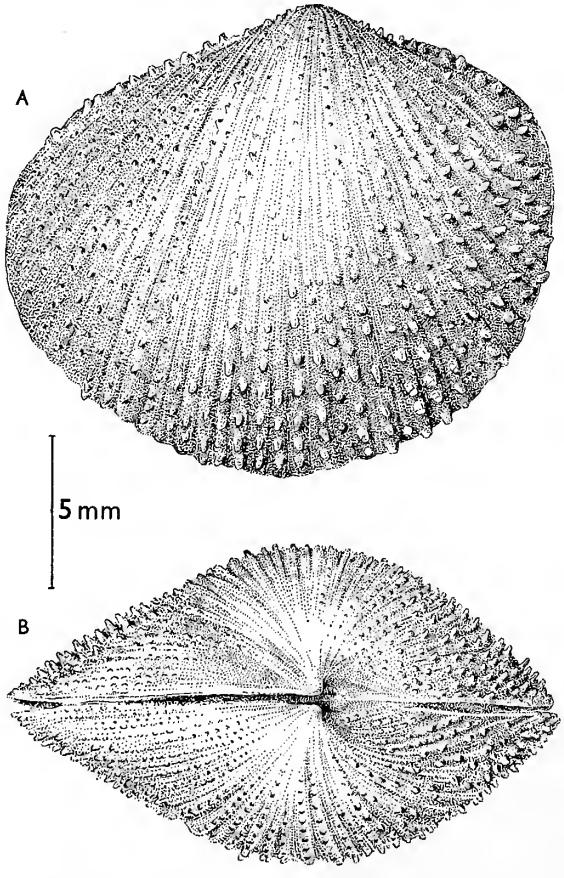


FIG. 29. *Euciroa eburnea* (Wood-Mason & Alcock); "*Galathea*" St. 302. (A) right valve, lateral view. (B) dorsal view. P.H.W.

Remarks: The present material agrees in all details with the description and figures of Wood-Mason & Alcock (1891a). Dall (1895) described in detail a very similar species, *E. pacifica*, from off Hawaii, at depths ranging from 535–680 m. The anatomy of the species is described. While *E. eburnea* and *E. pacifica* show many similarities in the shell, the lithodesma seems to differ in the two species, and is described as "deltiform, rounded below with a short, pointed process on each side behind". The two species also seem to differ in the tentacles of the siphon; Dall states that these are not arranged in rows in *E. pacifica*, and that they diminish towards the incurrent opening. The present author suggests that *E. eburnea* and *E. pacifica* are, therefore, to be kept as separate species.

Another very similar species is *E. cistagemma* Kuroda (1951) recorded from off Goto Is., Kyoshu (Japan Sea), 307 m depth. In this species, however, the umbo is much larger, giving the shell a pronounced rounded-triangular shape. The lithodesma is distinctly different, being rectangular with two pointed posterior lobes.

Euciroa millegemmata Kuroda & Habe (in: Kuroda 1952) is very close to *E. eburnea* in the general shape and sculpture of the shell (as is evident from the figures of the species). It differs, however, in the structure of the hinge by having a distinct lateral tooth not found in *E. eburnea*. In *E. millegemmata* the lithodesma has two pointed posterior lobes with a narrow interspace, while in *E. eburnea* the posterior end has two faint and widely separated rounded lobes. Kuroda & Habe do not describe the soft parts, but judging from the shell characters mentioned, there can be little doubt that *E. eburnea* and *E. millegemmata* are different species.

Distribution: Wood-Mason & Alcock based their description on a live specimen from "*Investigator*" St. 115, Andaman Sea, 340–400 m depth. Smith (1904) recorded the species from "*Investigator*" St. 229 and 232, off the Travancore Coast at depths of 658 and 786 m. A specimen containing remnants of the soft parts was obtained from the latter station (seen by the present author in the B.M.(N.H.)). The "*Albatross*" *Philippine Expedition* 1907–1910 dredged the species at four stations, all E. of Luzon at depths from 906–1473 m. All four samples which are kept in the U.S.N.M., Washington, D.C., have been examined by the present author. They contained united pairs of valves with remnants of soft parts. The known geographical range of *Euciroa eburnea* would seem to be from off S. Africa to the S.E. Asian waters. The vertical range of live specimens would be from 340–1473 m depth. The temperature range would appear to be from about 6 to about 11 °C. The "*Investigator*" station list indicates a temperature of 3·3 °C at St. 232. This may be a misprint, since other stations in the region have considerably higher temperatures (6–8 °C) at this depth.

Euciroa rostrata Thiele & Jaeckel, 1931

Text figs. 28 *E–G; pl.* 3, *figs.* 4, 5.

1931 *Euciroa rostrata* Thiele & Jaeckel p. 91, pl. 5, fig. 132.
1935 *Euciroa* (*Acreuciroa*) *rostrata*, Thiele p. 945, fig. 863.
1952 *Euciroa teramachii* Kuroda p. 15, figs. 19-20.
1959 *Euciroa* (*Acreuciroa*) *teramachii*, Kira p. 165, pl. 62, fig. 9.
1962 *Euciroa* (*Acreuciroa*) *teramachii*, Kira p. 182, pl. 63, fig. 9.

Material: *Th. Mortensen leg.:* St. 16, Java Sea, 7°35′S., 114°42′E.; depth: about 200 m; bottom: mud; gear: Sigsbee trawl. – 1 pair of united shells.

St. 29, Banda Sea, 5°38′S., 132°53′30″E.; depth: 430 m; bottom: mud; gear: trawl. – 1 shell.

St. 52, Banda Sea, 3°46′S., 132°49′35″E.; depth: 352 m; bottom: mud; gear: trawl. – 1 specimen, 2 shells.

St. 62, Banda Sea, 5°29′25″S., 132°50′E.; depth: 290 m; bottom: sand, shells; gear: trawl. – 1 specimen.

DESCRIPTION: The species is nacreous, has a beak-shaped posterior projection and is slightly inequivalve, the right valve covering the left dorsally. The shape of the shell is variable, depending partly on the size. In small shells (15–20 mm long) the dorsal edge is straight and the postero-ventral curvature is only faintly developed. With increasing size, however, the postero-dorsal edge becomes more concave and this also applies to the postero-ventral edge. The whole shell is covered by a characteristic radiating sculpture consisting of spiny ridges running from the umbo to the ventral edge of the shell. The larger shells have secondary, less prominent, but spiny, ribs on the ventral half of the shell, located in the interstices between the primary ribs. The first three of the radiating ribs running from the umbo to the postero-ventral sinus are more prominent than the remaining ones. The lunule is distinctly marked off, but is rather small. The prodissoconch has a length of about 330 μ. The right valve has a single prominent, rounded, central tooth. The radiating sculpture is clearly visible on the interior surface. The adductor scars are distinct, the anterior being somewhat more than twice the size of the posterior. The ventral edge of the shell is irregularly serrated corresponding to the radiating sculpture. The lithodesma is heart-shaped with two posterior rounded lobes. *The soft parts:* the ventral part of the mantle is distinctly thickened and the periostracum of the mantle edge is provided with small irregularly spaced spines; these have broad rounded bases and are about 0·2 mm long. The siphon is short and muscular. The incurrent opening is surrounded by about 35 small tentacles arranged in several concentric rows, those of the innermost rows gradually becoming smaller towards the opening. The excurrent opening has 5–6 small tentacles located dorsally. The oral palps are large and slender, and at the base of the anterior pair two distinct bulbs are visible. The foot is laterally compressed and provided with a distinct heel. A byssus gland could not be detected.

DIMENSIONS IN MM: The largest shell of the present material measures 53 × 40. Kuroda's type of *E. teramachii* measures 64·6 × 40·8.

REPRODUCTION: The species is hermaphrodite. The anterior male gonad, located on the surface of the hepatopancreas, is ramified, the one examined contained ripe spermatozoa. The female gonad is more compact, although anteriorly some branches are present. Large numbers of ripe eggs were present. They had a diameter of about 300 μ and were covered by a thin membrane.

FOOD: The stomach of one specimen contained about 20 foraminifera.

REMARKS: The present material agrees very well with the description and figure given by Thiele & Jaeckel (1931). The anatomy of the present species is very similar to that described in *E. pacifica* Dall (1895), but I have been unable to decide whether *E. pacifica* and *E. rostrata* are conspecific. Kuroda (1952) states that his species, *E. teramachi*, is very similar to *E. rostrata*, but differs in being larger, having a more dorsally curved posterior part and a keel running from the umbo to the postero-ventral edge of the shell. This keel tends to be broken up into 2–3 thin ribs in larger specimens. The present material shows some variation in the shape of the posterior part of the shell. As mentioned above, smaller shells have a rather straight postero-dorsal edge, while in larger shells this is concave. The umbonal-ventral keel is found in the shells up to 40 mm in length (Kuroda states *E. teramachi* to be 64·6 mm long), but is obsolete in larger ones. The sculpture and the hinge of the present material is like that of *E. teramachi*. It is therefore concluded that *E. teramachi* is probably a synonym of *E. rostrata*.

DISTRIBUTION: Thiele & Jaeckel based *E. rostrata* on material from "*Valdivia*" St. 119 off the W. coast of Sumatra at a depth of 470 m (shells only). Kuroda recorded the species from off S.E. Japan (Tosa Bay), 230 m. None of the authors mention the presence of live specimens. The present collection seems to contain the first live specimens known, and demonstrates its occurrence in S.E. Asian waters. The collections of the U.S.N.M., Washington, D.C., contains a united pair of valves (seen by the present author) dredged by the "*Albatross*" *Philippine Expedition* 1907–1910 (St. 5281, W. of Luzon, depth: 368 m). The known vertical range would be from about 200–368 m at a temperature of about 10°C.

Family **POROMYIDAE**

Poromya eximia Pelseneer, 1911

Text fig. 30; *pl.* 3, *figs.* 1, 2.

1911 *Poromya eximia* Pelseneer p. 78, pl. 26, figs. 3, 4.
1932a *Poromya* (*Cetoconcha*) *eximia*, Prashad p. 327, pl. 7, figs. 31, 32.
1952 *Cetoconcha eximia*, Ray p. 189.

MATERIAL: *"John Murray" Expedition:* St. 108, Zanzibar area, 5°18′06″S., 39°24′12″E.; depth: 786 m; bottom: grey mud; bottom temperature: 7·9°C; gear: Agassiz trawl. – 2 specimens. One of the specimens is without the right valve, the soft parts are, however, intact although somewhat distorted.

DESCRIPTION: The shell is semi-transparent and strongly inequilateral, the postumbonal part forming about 69% of the length. The right valve slightly overlaps the left. The valves are inflated, the breadth being equal to about 42% and the height about 92% of the length. The umbo is prominent and strongly incurved. The posterior end is laterally compressed and in dorsal view the outline is concave. Both valves have a sharp ridge running from the umbo towards the posterior end, close to the postero-dorsal edge and roughly parallel to it; the ridge is more distinct on the right valve. A shallow, indistinct depression runs from the umbo towards the postero-ventral edge, where it appears as a faint sinus. There is a faint, irregular concentric sculpture and a fine radiating sculpture, which becomes more distinct on the posterior part of the shell. The prodissoconch is eroded. The ligament is short and visible from the outside, and the hinge is devoid of teeth. The interior of the shell is smooth, and the above-mentioned umbonal-ventral depression is seen internally as a rounded ridge. The adductor scars are indistinct and oblong, the posterior being the larger; they are located close to the dorsal edge. *The soft parts:* the mantle has a thickened edge and the anterior two-thirds are free. The incurrent siphon is short and muscular, and the opening, which is approximately circular, is surrounded by six pairs of stout, pointed tentacles of equal size, arranged in a single row. The interior of the opening has a very large tongue-shaped valve, extending almost to the posterior edge of the foot. The valve is longitudinally curved, forming a tube which is open along the ventral edge. The excurrent opening is much smaller than the incurrent one, and appears as a short thick spout, open dorsally. Dorsal to the excurrent opening is a single stout tentacle, which is somewhat smaller than

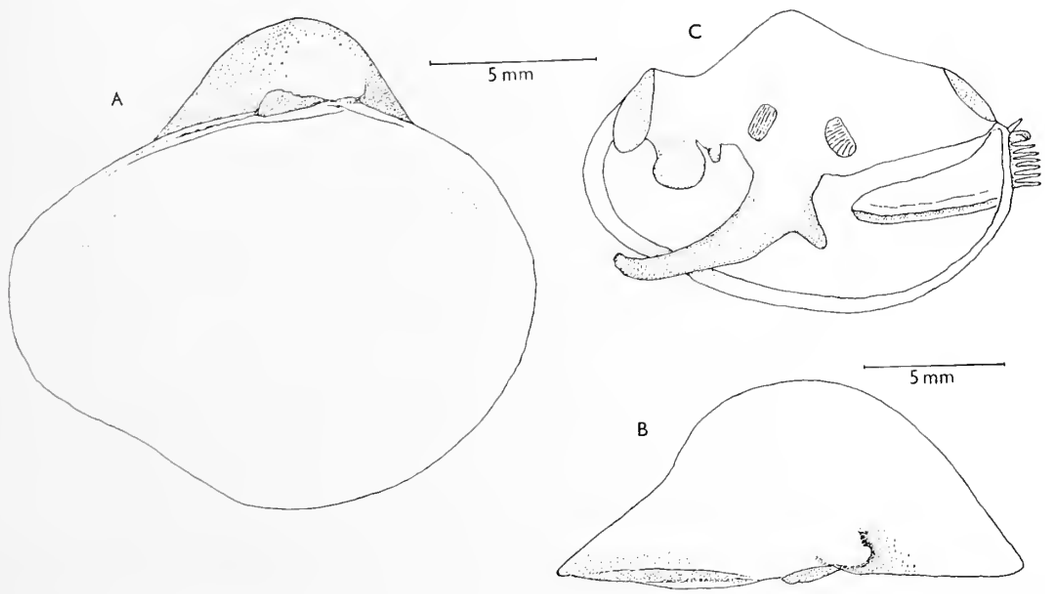


FIG. 30. *Poromya eximia* Pelseneer; *"John Murray"* St. 108. (A) interior of left valve. (B) dorsal view of left valve. (C) soft parts seen from the left.

those of the incurrent opening. The septum is thin and has two pairs of osculae. The anterior pair has six transverse bars crossed by six connective filaments. The posterior oscula has 11 transverse bars and five to six connective filaments. The anterior labial palps are large and cup-shaped, the posterior pair is small. The foot is long and pointed, circular in cross-section, and has a distinct posterior projection.

DIMENSIONS IN MM: The type measures 17·5 × 15·4 × 15·1.

REPRODUCTION: The species is hermaphrodite, both specimens having a male and a female gonad. Both female gonads contained ripe eggs with a diameter of about 140 μ.

FOOD: In both specimens the stomach contained a small amount of what appeared to be mainly remnants of small crustaceans but identification of these was not possible.

REMARKS: The present species was first provisionally named by Dautzenberg (Prashad 1932a) in an unpublished MS. The anatomy of the species was described by Pelseneer (1911), who also gave very good figures of the soft parts, but not the shell. Prashad (1932a) gave a very brief description and figured the shells of *P. eximia*, but although he attached n. sp. to his description, the previous description by Pelseneer undoubtedly constitutes the first published description of the species. The present material agrees well with the description and figures given by Pelseneer and Prashad. The former found two pairs of septal osculae. The anterior one has six transverse filaments, while the posterior has eleven. In both, six connective filaments were present. The foot shows the posterior projection also found in the "*John Murray*" specimens. The incurrent opening is surrounded by six pairs of tentacles and an additional tentacle dorsal to the excurrent opening. The valve is large, extending to the foot.

DISTRIBUTION: The type was obtained by the "*Siboga*" *Expedition*, at St. 314, Flores Sea, depth: 694 m, and was the only record of the species to date. The present record thus constitutes a considerable extension of the distribution of the species, being known from off E. Africa to the S.E. Asian waters at depths from 694–786 m. The temperature at "*Siboga*" St. 314 would be about 7·9°C.

Family **CUSPIDARIIDAE**

Cuspidaria alcocki E. A. Smith, 1894

Text fig. 31; *pl.* 3, *figs.* 16, 17, 18

1894 *Cuspidaria alcocki* E. A. Smith p. 170, pl. 5, fig. 8.
1897 *Cuspidaria alcocki*, Alcock & Anderson pl. 3, fig. 6.
1901 *Cuspidaria* (*Cardiomya*) *potti* Sturany p. 264, pl. 1, figs. 10-16.
1907 *Cuspidaria alcocki*, Melvill & Standen p. 847.
1931 *Cuspidaria* (*Cardiomya*) *alcocki*, Thiele & Jaeckel p. 98.
1940 *Cuspidaria alcocki*, Winckworth p. 28.
1964 *Cardiomya* (*Kurodamya*) *alcocki fortisculpta* Habe p. 214, pl. 65, fig. 15.

MATERIAL: *Th. Mortensen leg.:* St. 15, Java Sea, 7°29′S., 114°49′E.; depth: about 240 m; bottom: sand, and mud with concretions; gear: Sigsbee trawl. – 1 pair of united shells.

In addition, the present author has examined a sample from "Naturhistorisches Museum", Vienna, labelled "*Cuspidaria potti*, Golf von Oman, 156 Faden; I. C. Melvill don. 1903". The sample is obviously part of the samples reported by Melvill & Standen (1907).

DESCRIPTION: The shell is thin and semitransparent with a short posterior projection. The postumbonal part of the shell forms about 58% of the length, and the height is equal to about 60% of the length. The shell is provided with sharp radiating ribs, gradually becoming more prominent towards the posterior projection; the last three or four are particularly prominent. In the specimens seen there are 15–20 ribs running from the umbo to the ventral edge. In addition, there are varying

numbers of shorter and less prominent ribs running from the ventral edge towards the umbo which disappear at various distances before reaching the latter. This would seem to indicate that new ribs are added with the growth of the shell. The posterior projection has about four almost longitudinal ribs. In addition, there is a fine concentric sculpture, particularly distinct anteriorly, becoming more indistinct and irregular posteriorly. In the larger shells the concentric sculpture is on the whole less distinct than in the smaller ones. The sculpture is also clearly visible on the interior surface, owing to the transparency of the shell. The ventral edge of the shell is serrated, corresponding to the radiating ribs. The resilium is triangular and rather small. Posteriorly, there is a well-developed lateral tooth in both valves. The adductor scars are distinct. The anterior edge of the posterior scar is bound by a distinct rounded edge running ventrally from the umbonal cavity.

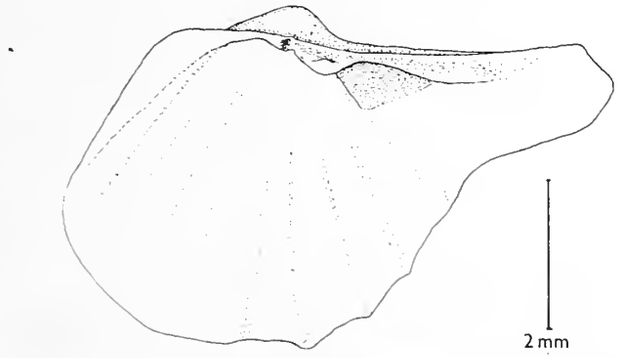


FIG. 31. *Cuspidaria alcocki* E. A. Smith; *Th. Mortensen* St. 15. Interior of left valve.

DIMENSIONS: The type: 16 × 9·5 × 7·3.

REMARKS: Sturany (1901) noted that *C. potti* is related to *C. alcocki*, the latter being larger and having 4–5 prominent radiating ribs. Smith (1894) states the length of *C. alcocki* to be 16 mm, viz., more than twice the length of *C. potti*, which has three prominent radiating ribs. Otherwise the two species agree in the shape of the shell, the sculpture and the hinge. By comparing the present specimens with the available figures of *C. alcocki* and *C. potti*, the author is strongly in favour of following Melvill & Standen's (1907) suggestion that the two species should be synonymized under Smith's name. The observed difference in the number of prominent ribs is certainly only due to the fact that new ribs are added during growth. Habe (1964) considered *C. fortisculpta* Kuroda a subspecies of *C. alcocki* (Kuroda, 1948, p. 20, pl. 2, fig. 16a–b).

DISTRIBUTION: Smith recorded *C. alcocki* from an "*Investigator*" dredging off Ceylon, 6°29′N., 79°34′E., (the longitude is erroneous in Smith's paper), at a depth of about 1092 m. No mention is made of live specimens. Sturany recorded the species from a number of "*Pola*" stations in the Red Sea, at depths between 562–747 m. It is mentioned that both live specimens and shells were present. Melvill & Standen recorded *C. alcocki* from the Gulf of Oman at two localities at about 285 and 73 m. The material studied here originates from the former locality; those from the latter locality are reported to be juveniles and no information is given as to live specimens; the specimens from the Vienna Museum were all dead shells. The identification of Melvill & Standen's material from 73 m depth should be checked, as the depth is much less than the other records of the species. Finally, Thiele & Jaeckel (1931) recorded *C. alcocki* from three stations of the "*Valdivia*" *Expedition* viz., St. 191, off Sumatra, depth: 750 m; St. 242, off E. Africa, depth: 404 m and St. 256, off E. Africa, depth: 1134 m. Only the last-mentioned station yielded a live specimen. The horizontal distribution thus comprises the Red Sea, the N. part of the Indian Ocean and the S.E. Asian waters. The vertical range is from 240(73?)–1134 m. The temperature range would be from 7·6 to 21–22°C (in the Red Sea).

Cuspidaria approximata E. A. Smith, 1896

Text fig. 32; *pl.* 3, *figs.* 8, 9.

1896 *Cuspidaria approximata* E. A. Smith p. 373.
1898 *Cuspidaria approximata*, Alcock & Anderson pl. 8, fig. 2, 2a.
1906 *Cuspidaria approximata*, E. A. Smith p. 264.
1907 *Cuspidaria approximata*, Melvill & Standen p. 847.
1931 *Cuspidaria approximata*, Thiele & Jaeckel p. 96.
1940 *Cuspidaria approximata*, Winckworth p. 28.
1964a *Cuspidaria approximata*, Barnard p. 581.

MATERIAL: *"John Murray" Expedition:* St. 108, Zanzibar area, 5°18′06″S., 39°24′12″E.; depth: 786 m; bottom: grey mud; bottom temperature: 7·9°C; gear: Agassiz trawl.– 1 specimen and 2 shells.

DESCRIPTION: The shell is inflated with a prominent umbo; the postumbonal part forms about 57% of the length of the shell; the height equals about 72% of the length. The posterior projection is short. The sculpture consists of a fine irregular concentric striation, gradually becoming more distinct and turning dorsally onto the dorsal part of the posterior projection. The latter has a fairly distinct ridge running from the umbo to the postero-ventral corner, and the posterior projection has 4–6 rather indistinct ridges. The hinge of the right valve has a very well-developed posterior tooth, but no anterior lateral tooth. The left valve is devoid of teeth. The interior of the shell is smooth. While the posterior adductor scar is distinct and elongate, the anterior adductor scar was not seen. *The soft parts:* the mantle edges are fused at their posterior half. The siphonal opening has about 12 small rounded papillae on each side, and the incurrent opening of the siphon is short, with four ventral, bulbous tentacles. The excurrent opening has three dorsal tentacles. The septum is nearly circular, thick and very muscular; it has five pairs of osculae. The anterior septal muscle is divided into three sections, of which the lateral section is the largest. The posterior septal muscle is very strong and the lateral septal muscles consist of 35–40 small muscles spread evenly along the edge of the septum, except for the posterior part of the edge. The foot is comparatively small, tongue-shaped, and with a ventral slit.

DIMENSIONS IN MM: The present specimen: 16·4 × 11·6 × 11·2.

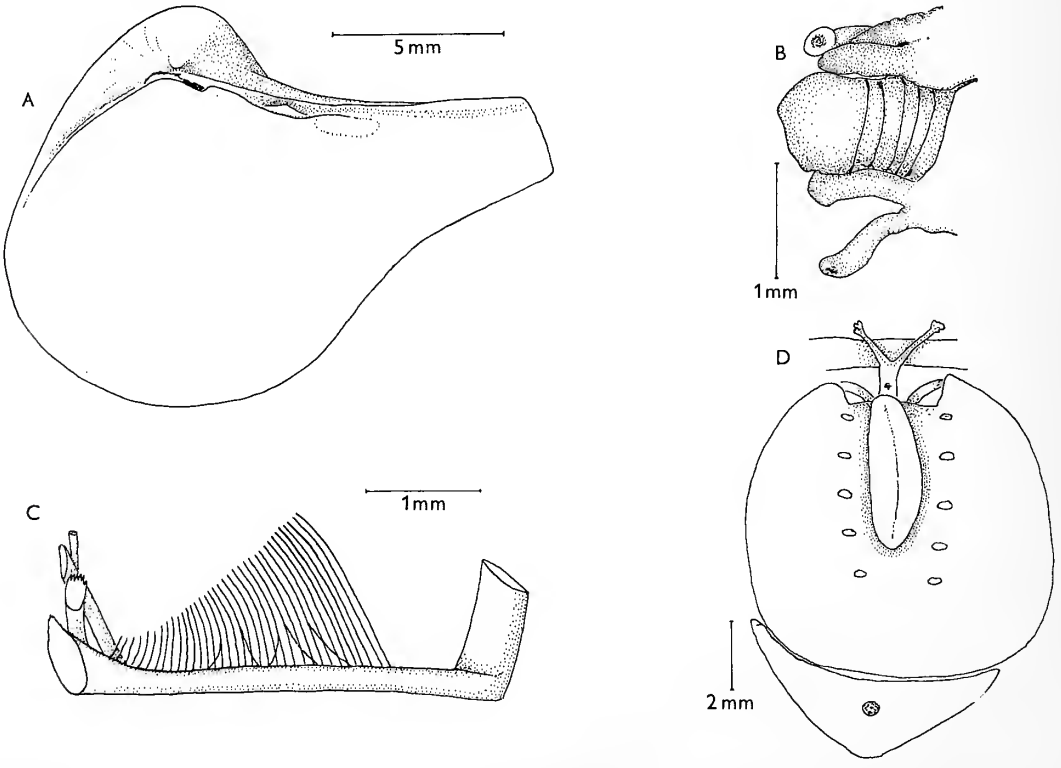


FIG. 32. *Cuspidaria approximata* E. A. Smith; *"John Murray"* St. 108. (A) interior of left valve. (B) distal end of siphon seen from the right side. (C) lateral view of septum and septal muscles seen from the left side (somewhat diagrammatic). (D) ventral view of septum and foot.

Remarks: The present material agrees very well with Smith's description (1896) and Alcock & Anderson's figure (1898). Melvill & Standen (1907) suggested that *C. brachyrhynchus* Sturany might probably be a synonym of *C. approximata*. The former species was described in detail and very well figured by Sturany (1901, p. 9, pl. 2, figs. 1–6). In comparing Smith's and Sturany's descriptions and figures with the present material, I am unable to agree with Melvill & Standen's suggestion, although it is agreed that the two species are very much alike. The shape of the umbo differs, that of *approximata* being more inflated, and in *C. brachyrhynchus* the posterior lateral tooth is shorter than in *C. approximata*. It also appears that the sculpture of the posterior projection differs in the two species. *C. approximata* is also very similar to *C. convexa*, the anatomy of which was described by Pelseneer (1911, p. 80, pl. 26, fig. 10), and the shell described and figured by Prashad (1932a, p. 329, pl. 7, figs. 36, 37). Pelseneer's figure shows, however, that *C. convexa* has a much longer siphon and a more elongate septum. It is further stated in the text that the anterior septal muscle is divided into two parts in *C. dubia*, but tripartite in *C. approximata*. Prashad figured the outside of the shell only; it appears to be very close to *C. approximata* in shape, but apparently it has a coarser sculpture.

Distribution: Smith (1896) recorded *C. approximata* from "*Investigator*" St. 116, Andaman Sea, depth: 741; later Smith (1906) recorded the species from "*Investigator*" St. 322, Andaman Sea, depth: 692 m. Melvill & Standen recorded *C. approximata* from depths of between 18 and 412 m in the Gulf of Oman, but as mentioned above, these authors considered *C. brachyrhynchus* a synonym of *C. approximata*. Thiele & Jaeckel (1931) recorded *C. approximata* from five "*Valdivia*" stations off the E. coast of Africa. The present author examined the material and found that at one station, viz., St. 241, off Dar es Salaam, depth: 465 m, one live specimen was obtained. In addition, shells with preserved ligaments were obtained from St. 443, depth: 400 m. Barnard records the species from off Umhloti River, Natal, S. Africa, where one live specimen and one valve were obtained at a depth of 46 m. Barnard (1964a) calls attention to the fact that the considerable difference in depth between his finding and previous findings raises doubt as to the identity of the Natal specimens with Smith's species. The horizontal distribution of the species thus extends from off the E. coast of Africa (off Natal – off Zanzibar) to the N.E. Indian Ocean. The known bathymetrical range is from (46?) 400–786 m. The temperature range would be from 7·9 to about 11°C.

Cuspidaria brachyrhynchus Sturany, 1901

Text fig. 33; pl. 3, fig. 10.

1901 *Cuspidaria brachyrhynchus* Sturany p. 263, pl. 2, figs. 1-6.

Material: "*John Murray*" *Expedition:* St. 207, Red Sea, 14°08′56″N., 42°19′E.; depth: 375 m; bottom: green-brown mud, pteropods; gear: grab. – 1 right valve (damaged).

Description: The shell is thin and semitransparent. The postumbonal part forms 60% of the length of the shell. The height equals 61% of the length and the breadth 22%. The postero-dorsal edge is nearly straight. The sculpture consists of a fine irregular concentric striation, which gradually becomes more distinct and close set towards the periphery. The striation is dorsally curved on the posterior projection, which is completely devoid of longitudinal ridges. The resilium is small. The hinge has a posterior lateral tooth. The posterior adductor scar is rather distinct; its anterior edge reaches the point of the lateral tooth. A faint rounded ridge runs from the umbonal cavity to the ventral edge at a short distance anterior to the posterior adductor scar. This ridge can also be distinguished on the outside of the shell. The concentric sculpture can also be seen on the interior surface.

Dimensions in mm: Sturany: 13·6 × 8·3 × 7·8.

Remarks: *C. brachyrhynchus* was described and figured by Sturany (1901), based on material from the Red Sea. The present shell seems to agree fairly well with the figures and description.

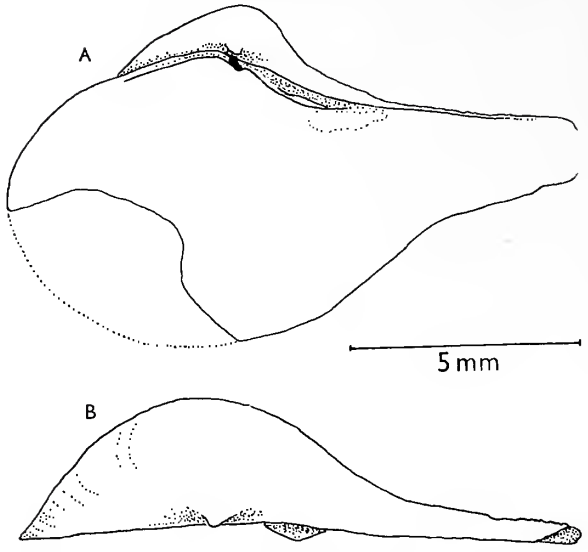


FIG. 33. *Cuspidaria brachyrhynchus* Sturany; "*John Murray*" St. 207. (A) interior of right valve. (B) dorsal view.

Sturany's shells were, however, somewhat broader, the breadth of his shells being about 29% of the length. Moreover, one of his drawings shows a striation of the lateral tooth which could not be seen in the present shell. However, good agreement was found in the position of the posterior adductor scar in relation to the lateral tooth, and Sturany's illustration shows the faint ridge from the umbo to the ventral edge and the absence of longitudinal ridges on the posterior. Both the present shell and Sturany's material differ from *C. approximata* by a more laterally compressed shell, and a relatively smaller umbo. In *C. approximata* the base of the lateral tooth continues as a faint ridge extending to the extreme tip of the posterior projection. The posterior adductor scar of *C. approximata* is located posterior to the lateral tooth, while, as already mentioned, in *C. brachyrhynchus* the adductor scar extends to the point of the lateral tooth. The identification of the present shell remains somewhat uncertain.

DISTRIBUTION: Sturany found the species in 6 localities in the Red Sea, at depths between 439 and 2160 m.

Cuspidaria caduca E. A. Smith, 1894

Text fig. 34; *pl.* 3, *fig.* 11.

1894 *Cuspidaria* (*Myonera*) *caduca* E. A. Smith p. 170, pl. 5, figs. 9, 10.
1931 *Cuspidaria caduca*, Thiele & Jaeckel p. 98.
1940 *Cuspidaria caduca*, Winckworth p. 28.
1948 *Myonera fluctuosa* Kuroda p. 25, pl. 2, fig. 20.
1958a *Myonera fluctuosa*, Habe p. 279.
1959 *Myonera fluctuosa*, Kira p. 164, pl. 62, fig. 1.
1962 *Myonera fluctuosa*, Kira p. 181, pl. 63, fig. 1.

MATERIAL: "*Galathea*" *Expedition:* St. 202, off Natal, 25°20'S., 35°17'E.; depth: 575–595 m; gear: dredge. – 6 specimens and 2 shells.

DESCRIPTION: The shell is white, thin and semitransparent; the postumbonal part forms about 60% of the total length; the height equals about 44% of the length and the breadth about 35%. The posterior projection is rather narrow and laterally compressed. The shell has a very distinct concentric sculpture consisting of sharp ridges, which near the umbo are narrow and regularly spaced. Towards the ventral edge the ridges become less distinct and more irregular in shape, and they disappear close to the ventral edge. Besides this sculpture, there is a fine irregular striation present all over the shell.

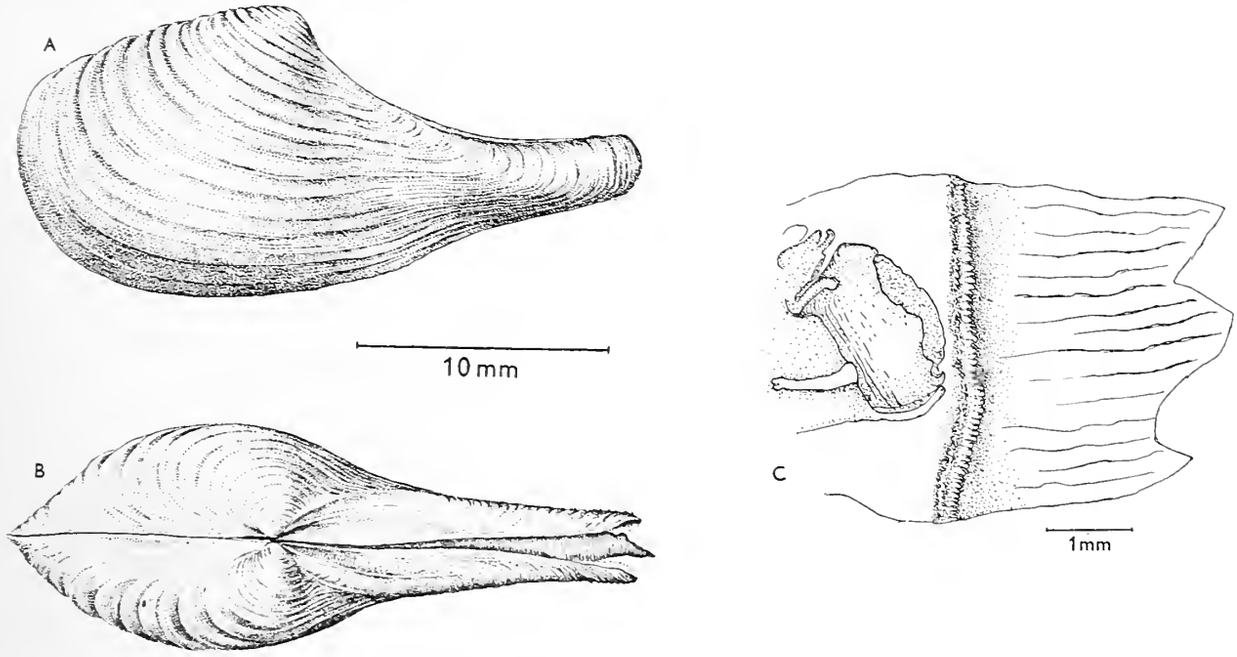


FIG. 34. *Cuspidaria caduca* E. A. Smith; "*Galathea*" St. 202. (A) lateral view of left valve. (B) dorsal view. (C) distal end of siphon seen from the left. (A, B) P.H.W.

The prodissoconch has a length of about 155 μ. From the umbo two fine, but distinct ridges run in a posterior direction; the median one runs to the posterior edge of the shell and delimits a lanceolate area on the postero-dorsal part. The other ridge becomes indistinct about half-way to the posterior edge. The right valve has a posterior lateral tooth, but otherwise no teeth are present. The concentric ribs of the outer surface of the shell appear as a distinct undulate sculpture on the inner surface. The adductor scars are relatively large; the anterior rather indistinct, and the posterior deeply impressed. *The soft parts:* the mantle edges are thickened and fused along their posterior half. The siphon is short and surrounded by an extension of the conchiolin layer, which is longitudinally folded and distally projects into four pointed lobes. The internal wall of the outer tube has a circular row of small rounded tentacles, and at the base of this there is a fine folded ridge. The incurrent opening is wide and provided with four tentacles, of which two are ventral and close together. The excurrent opening is much smaller and has three tentacles. All the tentacles are approximately of uniform size and somewhat bulbous at the distal end. The foot is circular in cross section and has a posterior longitudinal slit. The septum is extremely muscular and has four pairs of osculae and four pairs of retractors; of these, the anterior and posterior pairs are very strongly developed, while the two lateral pairs are very much less so.

DIMENSIONS IN MM: Type specimen: 32 × 14 × 10.

REPRODUCTION: Two females contained ripe eggs with diameters of 125–135 μ.

FOOD: The stomach contents were examined in two specimens. One specimen contained a small (unidentified) fish scale and the operculum of a gastropod; the other contained remnants of small crustaceans (Copepoda ?).

REMARKS: The present material agrees very well with Smith's (1894) description and figures. Kuroda (1948) states that the species described under the name of *C. fluctuosa* is somewhat similar to *C. caduca*. The latter is, however, longer (32 mm compared with 27); the main part of the valve is shorter, and the postero-ventral margin is slightly straighter. In the Japanese species, this part is projected and curved, and the concentric undulating lines are finer. After comparing the descriptions and figures of *C. caduca* and *C. fluctuosa* with the present material, it is concluded that *C. fluctuosa* is a

synonym of *C. caduca*. The "*Galathea*" specimens agree in all details with Kuroda's description. The curvature of the postero-ventral edge is as figured by Kuroda, and also the presence of a posterior lateral tooth of the right valve noted by Kuroda is seen in the present specimens.

DISTRIBUTION: Smith figured a united pair of shells from "*Investigator*" St. 115, Andaman Sea, depth: 340–400 m. Thiele & Jaeckel (1931) recorded *C. caduca* from two "*Valdivia*" stations off E. Africa, St. 256 at 1134 m depth (a live specimen). Habe (1958a) recorded *C. fluctuosa* from several localities off the S.E. part of Japan, from off Chiba Prefecture at about 35°N. to Goto I., S.W. Japan, at depths ranging from 84–325 m. Unfortunately, none of the Japanese records refers to live specimens. The horizontal distribution is thus considerable, extending from off Natal, S.E. Africa to off S. Japan. The vertical range of the species is from (84) 340–400 down to 1134 m; in the region around Japan the species seems to live at shallower depths. The temperature range of *C. caduca* would be from 7·6 to 13·3°C. The Japanese records may indicate that the species has a somewhat higher upper temperature limit, probably about 18°C.

Cuspidaria dubia (Pelseneer, 1911)

Text fig. 35.

1911 *Myonera dubia* Pelseneer p. 80, pl. 26, fig. 11.
1932a *Cuspidaria* (*Rhinoclama*) *dubia*, Prashad p. 333, pl. 7, figs. 49, 50.
1962 *Cuspidaria* (*Rhinoclama*) *dubia*, Okutani p. 37, pl. 3, fig. 10.

MATERIAL: "*John Murray*" *Expedition:* St. 158, Maldive area, 4°42′30″N., 72°42′30″E.; depth: 786–1170 m; gear: Agassiz trawl. – 2 specimens.

DESCRIPTION: The shell is thin and semitransparent. The umbo is low, the postumbonal part forms about 60% of the length of the shell, the height equals about 66%. The antero-dorsal edge is slightly convex, while the postero-dorsal edge is straight or slightly concave. The two edges form a rounded angle, a little anterior to the umbo. The concentric sculpture is distinct and consists of regularly interspaced very narrow ribs, which are dorsally curved on the posterior projection, becoming considerably more distinct close to the postero-dorsal edge. A very pronounced ridge runs from the umbo to the postero-ventral angle of the posterior projection. The ridge is nodulose owing to the crossing of the concentric ribs. The resilium is small. The right valve has very distinct lateral teeth, of which the posterior one is much more prominent than the anterior. The hinge of the left valve is devoid of teeth. The interior of the shell is smooth and glossy. While the anterior adductor is hardly visible, the posterior is rather distinct and triangular. *The soft parts:* the mantle edges are fused for more than half the distance between the adductor muscles, leaving only a rather small pedal opening. The siphon is short. The incurrent opening has four ventral tentacles, and the excurrent opening has three dorsal tentacles. The septum is extremely muscular, and has four pairs of osculae, the two anterior pairs being located close to the anterior end. The septum has no real lateral retractors. The foot is very small.

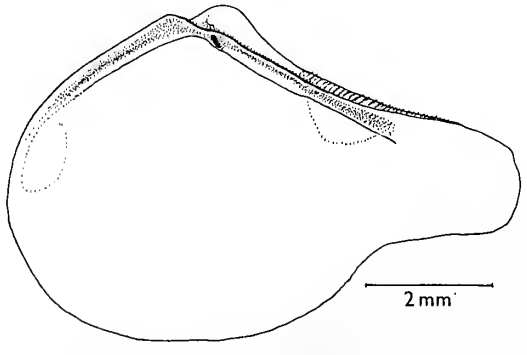


FIG. 35. *Cuspidaria dubia* Pelseneer; "*John Murray*" St. 158. Interior of right valve.

DIMENSIONS IN MM: Present specimen: 10·0 × 7·1 × 5·4.

REPRODUCTION: One specimen examined was a female containing ripe eggs with a diameter of about 180 μ.

FOOD: The stomach of one of the specimens was examined and found to contain a small number of Foraminifera.

REMARKS: Pelseneer (1911) gave a short account and a figure of the gross anatomy of the species. The present material agrees very well with this. Prashad (1932a) described and figured the shell. I have examined a specimen designated as the holotype from "*Siboga*" St. 211, and found it to agree in all details with the present material. Okutani (1962) gives a good figure of a shell, and it is quite certain that his material is *C. dubia*.

DISTRIBUTION: Pelseneer did not indicate from which "*Siboga*" station his material came. The depth is, however, stated to be 1788 m; this would indicate "*Siboga*" St. 271, Arafura Sea – the only station of the expedition having that depth. Prashad recorded *C. dubia* from two "*Siboga*" stations: St. 211, Flores Sea: 1158 m and St. 221, Banda Sea: 2798 m, but did not include any material from St. 271. The present author has seen a specimen from St. 211, designated as the "type" by Prashad, containing the dry soft parts. It is uncertain whether the material from St. 221 consists of shells only or live specimens. Okutani recorded *C. dubia* from two stations of the "*Soyo-Maru*", viz.: St. 51, off S.E. Japan, depth: 1560–1640 m, and St. B 2, off S.E. Japan, depth: 1230–1350 m. Live specimens are recorded from both stations. The total horizontal range of the species thus extends from off S.E. Japan to the C. part of the Indian Ocean. The species lives from between 786–1170 m down to 1788 m (and possibly deeper – see above). The temperature range of the species would be from about 2 to about 7°C.

Cuspidaria kawamurai Kuroda, 1948

Text fig. 36; *pl.* 3, *figs.* 12, 13.

1932a *Cuspidaria gigantea* Prashad p. 329, pl. 7, fig. 38.
1948 *Cuspidaria kawamurai* Kuroda p. 11, pl. 1, fig. 4.
1961 *Cuspidaria kawamurai*, Habe p. 145, pl. 65, fig. 13.
1962 *Cuspidaria kawamurai*, Okutani p. 34.
1964 *Cuspidaria gigantea kawamurai*, Habe p. 214, pl. 65, fig. 13.

MATERIAL: "*John Murray*" *Expedition:* St. 109, Zanzibar area, 5°10′36″S., 39°33′48″E.; depth: 640 m; bottom: light grey mud; bottom temperature: 8·9°C; gear: Agassiz trawl. – 1 shell.

St. 145, Maldive area, 4°58′42″S., 73°16′24″E.; depth: 494 m; gear: Agassiz trawl. – 3 shells.

"*Galathea*" *Expedition:* St. 202, off Natal, S. Africa, 25°20′S., 35°17′E.; depth: 575–595 m; gear: sledge trawl, dredge. – 1 specimen, 1 shell.

St. 490, Bali Sea, 5°25′S., 117°03′E.; depth: 545–570 m; bottom: sand and clay; gear: sledge trawl, dredge. – 1 shell.

DESCRIPTION: The shell is thick, inequivalve, with a low umbo and a relatively long tube-like posterior projection or spout. The periostracum is thick and brown. The postumbonal part forms about 60% of the length of the shell; the height equals about 50% of the length, and the breadth about 33%. The sculpture consists of a coarse and irregular concentric striation. From the umbo of each valve a very pronounced rounded edge runs to the postero-ventral corner of the posterior spout. A deeply impressed elongate area is also present, extending from the posterior part of the umbo to the extreme end of the spout. The periostracum of this area is distinctly darker than that of the rest of the shell, and the shape of the area itself differs somewhat in the two valves. The resilium is deeply impressed. The right valve has a well-developed posterior lateral tooth. No real anterior tooth is present, only a thickening of the antero-dorsal wall; this is also the case on both sides of the left valve.

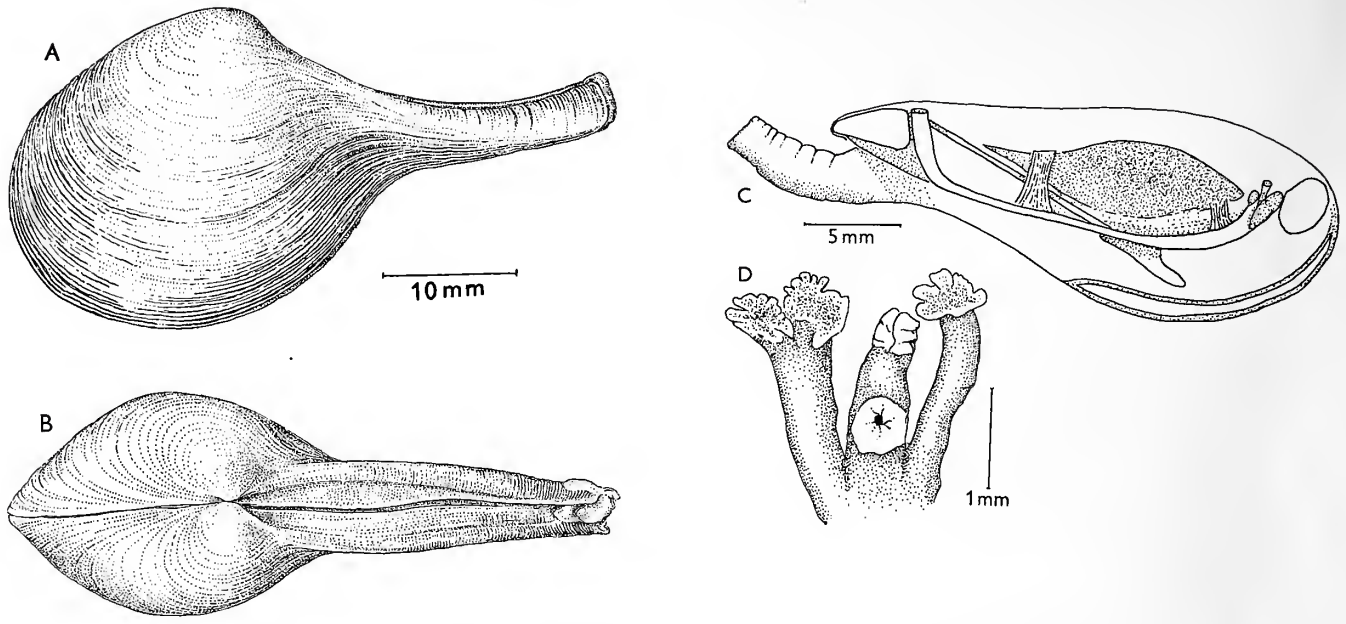


FIG. 36. *Cuspidaria kawamurai* Kuroda; "*Galathea*" St. 202. (A) lateral view of left valve. (B) dorsal view. (C) soft parts seen from the right side. (D) excurrent opening with dorsal tentacles, ventral view. (A, B) P.H.W.

The interior of the shell shows a fine radiating striation. The pallial impression shows a broad sinus located ventral to the posterior adductor scar. The interior of the posterior projection has two rounded longitudinal ridges. In one specimen only one longitudinal ridge is present. The posterior adductor scar is triangular and deeply impressed, but the anterior is much less distinct, and circular. *The soft parts:* the mantle is thickened, the pedal opening extends about half the length of the body. Posteriorly, the siphon is developed into a long muscular tube, finely dentate distally. Both siphonal openings are located close together at the extreme end of the siphon. The tentacles of both the incurrent and excurrent openings (four and three respectively) have irregular distal discs, the edges of which are strongly folded. The left tentacle of the excurrent opening has two well-separated discs. The septum is muscular and has four pairs of osculae. The anterior retractor is divided into three parts. Two lateral retractors are present, of which the anterior one is located close to the anterior retractor. The foot is relatively large, circular in cross section; the byssal groove appears as a longitudinal slit running from the base of the foot to the distal end.

DIMENSIONS IN MM: The largest specimen of the present collection: 54 × 26 × 18.

REPRODUCTION: The single specimen present contained numerous eggs which appeared to be mature, with diameters of 185–200 μ.

FOOD: The stomach contained a small amount of food, amongst which a few unidentifiable remnants of small crustaceans could be seen.

REMARKS: *C. gigantea* was described by Prashad (1932a), based on a single right valve from the "*Siboga*" *Expedition*. I have compared this type with the present material and found that it agrees closely. The specific name *gigantea* appears to be preoccupied by Verrill (1884). Kuroda (1948) described *C. kawamurai* from off S.E. Japan. He states that *C. kawamurai* is nearly identical with *C. gigantea*, differing, however, by the fine and irregular sculpture (termed "very regular" in Prashad's description), and in the presence of a low and broad anterior lateral tooth. If, however, Kuroda's description and good figures of *C. kawamurai* are compared to the present collection, there can be no doubt that *C. kawamurai* should be considered a synonym of *C. gigantea*. The present material shows some variation in the sculpture, the relative length and the curvature of the posterior projection and in the thickening of the antero-dorsal wall. Habe (1964) considered *C. kawamurai* a form of *C. gigantea*.

DISTRIBUTION: Prashad's shell was dredged at "*Siboga*" St. 159, S.E. Asian waters, 411 m. Kuroda recorded his species off S.E. Japan, but did not give any depth or indicate, whether live specimens were obtained. Okutani (1962) recorded another (live ?) specimen from "*Soyo-Maru*" St. 53, Sagami Bay, 740–1030 m. The horizontal distribution thus extends from off S.E. Africa to off S.E. Japan at depths ranging from 575–595 m down to 740–1030 m. The temperature range is from about 5 to about 11·3°C.

Cuspidaria macrorhynchus E. A. Smith, 1895

Text figs. 37A, B; pl. 3, figs. 14, 15.

1895a *Cuspidaria macrorhynchus*, E. A. Smith p. 12, pl. 2, fig. 5, 5a.
1897 *Cuspidaria macrorhynchus*, Alcock & Anderson pl. 3, fig. 5, 5a.
1902 *Cuspidaria macrorhynchus*, Alcock p. 282, fig. 82.
1931 *Cuspidaria macrorhynchus*, Thiele & Jaeckel p. 97.
1932a *Cuspidaria macrorhynchus*, Prashad p. 328, pl. 9, fig. 17.
1937 *Cuspidaria macrorhynchus*, Viader p. 69.
1940 *Cuspidaria macrorhynchus*, Winckworth p. 28.
1940 *Cuspidaria suganumai*, Nomura p. 101, pl. 2, figs. 13a, b.
1948 *Cuspidaria suganumai*, Kuroda p. 12, pl. 1, fig. 1.
1952 *Cuspidaria macrorhynchus*, Ray p. 189.
1958 *Cuspidaria suganumai*, Habe p. 278.
1959 *Cuspidaria suganumai*, Kira p. 164, pl. 62, fig. 2.
1962 *Cuspidaria suganumai*, Kira p. 181, pl. 63, fig. 2.
1964a *Cuspidaria macrorhynchus*, Barnard p. 581.

MATERIAL: "*John Murray*" *Expedition:* St. 107, Zanzibar area, 5°15′30″S., 39°33′E.; depth: 421–457 m; gear: Agassiz trawl. – 1 pair of united shells.

St. 158, Maldive area 4°42′30″N., 72°42′30″E.; depth: 786–1170 m; gear: Agassiz trawl. – 2 shells.

St. 185, Gulf of Aden, 13°48′06″N., 49°16′48″E.; depth: 2000 m; bottom: green mud; gear: Agassiz trawl. – 2 shells.

DESCRIPTION: The shell is thin and has a relatively long posterior projection. The postumbonal part forms about 59% of the length, the height equals about 51%. The antero-dorsal edge is slightly convex, the postero-dorsal edge nearly straight or slightly concave. The posterior part of the ventral edge runs almost parallel to the postero-dorsal edge, forming the rather long and straight posterior projection. The sculpture consists of a fine, irregular concentric striation, and the dorsal part of the posterior projection has a somewhat coarser sculpture, orientated at right angles to the longitudinal axis. This sculpture is only separated from that of the rest of the shell by a row of irregular and faint pits. The right valve has a well developed posterior lateral tooth, but no anterior tooth; the left valve is without teeth. The resilium is a small rounded plate. The interior of the shell is smooth but shows a fine radiating striation. The posterior projection has one or two longitudinal ridges located in the dorsal half and running from the base almost to the distal end. The adductor scars are distinct; the anterior one is oval, and the posterior rounded-triangular.

DIMENSIONS IN MM: Barnard (1964a): 27 × 12·5.

REMARKS: The present material agrees well with the description and figures of Smith (1895a). It should be noted, however, that the internal ribs of the posterior projection (found in the present shells) are not mentioned or figured by Smith. However, the shape of the shell and the hinge strongly indicate that the "*John Murray*" material is identical with Smith's species. Prashad (1932a) gives a figure of a specimen referred to *C. macrorhynchus* from the "*Siboga*" *Expedition;* his illustration shows the posterior projection to be somewhat shorter than those in both Smith's figured specimens. Prashad states that the length of the rostrum varies somewhat. I have examined the "*Siboga*" material

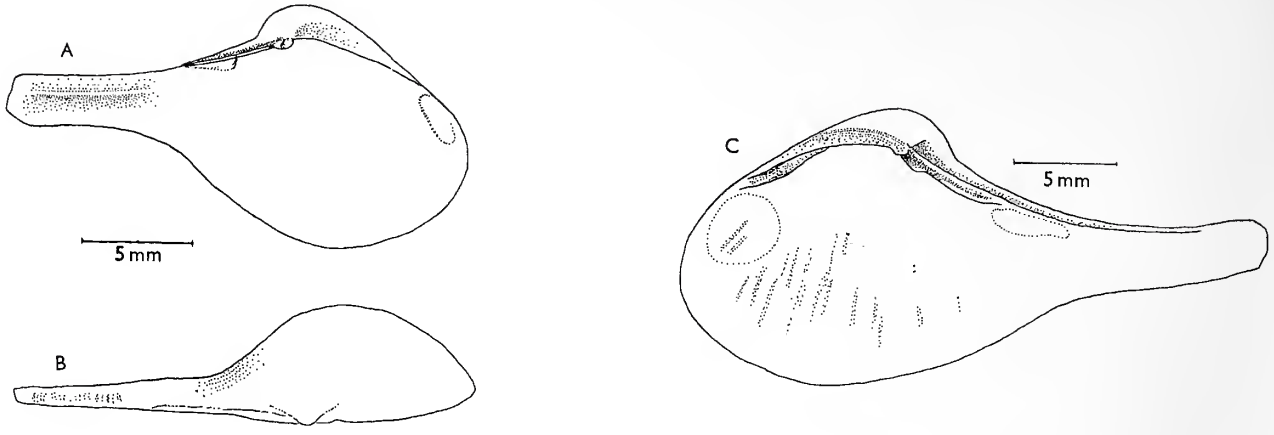


FIG. 37. (A, B) *Cuspidaria macrorhynchus* E. A. Smith; "*John Murray*" St. 185. (A) interior of left valve. (B) dorsal view. (C) *Cuspidaria steindachneri* Sturany; "*John Murray*" St. 6. Interior of right valve.

and found it identical with the present samples. Nomura (1940) established and figured *C. suganumai* from off S.E. Japan. Only a single right valve was available. An actual description is not given, but it is stated that *C. suganumai* is closely allied to *C. chinensis*, even though the valve is slightly more convex and the umbo is more swollen. In *C. suganumai*, the upper margin of the rostrum is perhaps less arched, the surface sculpture is decidedly finer, and not so distinct as in *C. chinensis*. Kuroda (1948) discussed *C. suganumai* more thoroughly, in addition to giving good figures; it is stated that the species is very similar to *C. macrorhynchus*, although the latter is smaller, has a longer rostrum, and has, as stated by Smith, a fine radiating sculpture. It is further stated by Kuroda that the distal part of the posterior projection is narrow in *C. suganumai*, while it is broader in *C. macrorhynchus*. In addition the antero-dorsal margin (of the right valve) has a groove which receives the edge of the left valve. Comparing the available descriptions and figures of *C. suganumai* with the "*John Murray*" material and the descriptions and figures of *C. macrorhynchus* the present author is strongly convinced that *C. suganumai* is synonymous with *C. macrorhynchus*.

DISTRIBUTION: Smith recorded *C. macrorhynchus* from "*Investigator*" St. 177, Laccadive Sea, depth: 1166 m. The presence of live specimens is not mentioned, but since a united pair of valves is figured, it must be assumed that at least one live specimen was obtained. Thiele & Jaeckel (1931) recorded *C. macrorhynchus* from five "*Valdivia*" stations, all from E. Africa at depths ranging from 400–1134 m. The presence of live specimens is not recorded, and the collections have not been examined by the present author. Prashad recorded *C. macrorhynchus* from two "*Siboga*" stations in S.E. Asian waters: St. 102, depth: 525 m, and St. 300 at 918 m depth. The material has been examined by the present author, who found a specimen containing the dry soft parts in the sample from the latter station. Viader (1937) recorded the species from off Mauritius, but gave no further data. Ray (1952) recorded a specimen from the Indian Ocean, also without further data. Nomura (1940), Kuroda (1948) and Kira (1959) recorded the species from off S.E. Japan at depths ranging from 106–177 m, but none of these authors states whether live specimens were obtained. In the collection of M.C.Z., Harvard, I have seen a specimen, with dry soft parts, labelled *C. suganumai* Nomura originating from Tosa Bay, S.E. Japan, depth 220 m. Finally, Barnard (1964a) recorded a live specimen from off S.E. Africa at a depth of 805 m. The horizontal distribution thus extends from off S.E. Africa to off S.E. Japan, at depths ranging from 220 (106–177) to 918; off Japan it seems to live in shallower water. The temperature range would be from about 5 to about 10°C.

Cuspidaria steindachneri Sturany, 1901

Text fig. 37C; pl. 3, figs. 19, 20.

1901 *Cuspidaria steindachneri*, Sturany p. 261, pl. 1, figs. 5-9.
1948 *Cuspidaria hirasei*, Kuroda, p. 10, pl. 1, fig. 3.
1959 *Cuspidaria hirasei*, Kira p. 165, pl. 62, fig. 5.
1962 *Cuspidaria hirasei*, Kira p. 181, pl. 63, fig. 5.

Material: *"John Murray" expedition:* St. 6, Red Sea, 17°06′18″N., 40°37′24″E.; depth: 1167 m; bottom: rock, shells; bottom temperature: 21·6°C; gear: dredge. – 5 shells.

Description: The shell is rather thick and has a long posterior projection, which is separated from the anterior portion of the shell by a shallow but rather distinct furrow. The postumbonal part of the shell forms about 60% of the length, and the height equals about 47%. The antero-dorsal edge is slightly convex, while the postero-dorsal edge is concave. The concentric sculpture is rather coarse and irregular, and the postero-dorsal part of the posterior projection has a still coarser, almost foliaceous sculpture, arranged at approximately right angles to the longitudinal axis. This sculpture is separated from the rest of the shell by a fine ridge running from the umbo to the postero-ventral edge. The ridge is very sharp near the umbo, becoming indistinct distally. Anterior to the ridge is a broad shallow groove, becoming more distinct distally. A deeply depressed narrow area runs from the umbo to the distal end of the posterior projection. The hinge has a rather small resilium; anterior to this, the dorsal edge is ventrally curved and somewhat flattened. In the three larger shells there is a considerable thickening below the antero-dorsal edge, but no development of a real lateral tooth. In the two smallest shells the thickening is absent, and in the three larger shells it is seen to be dependent on the size of the shell itself. The posterior lateral tooth is distinct in all shells. The adductor scars are distinct, the anterior one being large and rounded, the posterior elongate. The ventral half of the shell's interior has a radiating sculpture, and this area is distinctly marked off from the non-sculptured dorsal part. The pallial sinus is broad and deep. The posterior projection is provided with two longitudinal ridges.

Dimensions in mm: The largest shell measured by Sturany (1901): 29·2 × 13·0 × 11·2.

Remarks: The present shells agree in all details with Sturany's (1901) description, which is accompanied by very good figures. The radiating striation of the ventral part of the interior is not mentioned by Sturany, but is shown in figs. 6 and 7. Sturany mentions the thickening of the shell below the antero-dorsal edge (also observed in the present shells). Kuroda (1948) described *C. hirasei* from off S.E. Japan. In addition to a good description, he gives excellent figures of the species and discusses its relation to *C. steindachneri*. It is concluded that the two species differ in several respects. In *C. hirasei* the anterior part of the shell is more elongate than in *C. steindachneri*; in the former the rostrum is straight while in the latter it is dorsally curved. The position of the posterior lateral tooth of the left valve also differs in the two species: it is situated at a short distance from the resilium in *C. hirasei*, while in *C. steindachneri* they almost meet. Some variation is seen in the "*John Murray*" shells regarding the shape of the anterior part and the curvature of the posterior projection. In fact, most shells show a more elongate shape, and the said curvature is subject to some variation. The position of the posterior lateral tooth in relation to the resilium does not seem to differ in the two species. Unfortunately, the "*John Murray*" material contains only a single, somewhat damaged left valve, showing a posterior lateral tooth located at some distance from the resilium. It would seem, that Sturany figured a shell in which this tooth is damaged. What appears as a tooth close to the resilium in his illustration is possibly only the proximal part of the base of the broken off tooth. From this it might be concluded with some certainty that *C. hirasei* should be considered a synonym of *C. steindachneri*.

DISTRIBUTION: Sturany recorded *C. steindachneri* from a number of "*Pola*" stations in the Red Sea. No mention is made of live specimens, but from the table of measurements given, it appears that "complete" specimens (with united valves) were obtained at the following stations: St. 9, depth 791 m; St. 72, depth 1082 m; St. 96, depth 350 m; St. 121, depth 690 m; and St. 176, depth 612 m. Thus the available data indicates a depth range in the Red Sea from 350–1082 m. Neither Kuroda nor Kira mention live specimens; the species is recorded from Tosa Bay, S.E. Japan; the depth range is stated to be 106–183 m.

GENERAL PART

LIST OF STATIONS AT WHICH THE MATERIAL OF THE PRESENT REPORT WAS OBTAINED, WITH THE SPECIES OBTAINED AT EACH STATION

*Shells only.

The "John Murray" Expedition 1933-34:

St. 6, Red Sea, 17°06′18″N., 40°37′24″E.; depth: 1167 m; bottom: rock, shells; bottom temperature (at 1000 m): 21·6°C; gear: dredge; date: 14.9.1933.
**Cuspidaria steindachneri.*

St. 26, Gulf of Aden, 12°29′30″N., 50°51′30″E.; depth: 2312 m; bottom: soft, grey white mud; bottom temperature (at 2290 m): 2·7°C; gear: Agassiz trawl; date: 11.10.1933.
Tindaria murrayi
Spinula filatovae
Acar asperula
Limopsis pelagica

St. 33, Gulf of Aden, 13°41′N., 48°17′E.; depth: 1295 m; bottom: grey mud; bottom temperature (at 1280 m): 7·2°C; gear: Agassiz trawl; date: 15.10.1933.
Amussium caducum

St. 34, Gulf of Aden, 13°05′36″N., 46°24′42″E.; depth: 1022 m; bottom: green mud; bottom temperature (at 1000 m): 10·2°C; gear: Agassiz trawl; date: 16.10.1933.
Amygdalum politum

St. 42, South Arabian Coast, 17°26′N., 55°49′E.; depth: 1415 m; bottom: rock, mud; bottom temperature (at 1316 m): 6·7°C; gear: triangular dredge; date: 27.10.1933.
**Lucina bengalensis*

St. 54, South Arabian Coast, 21°50″N., 59°52′E.; depth: 1046 m; bottom: green mud; bottom temperature (at 900 m): 9·6°C; gear: Agassiz trawl; date: 3.11.1933.
Acila divaricata

St. 59, South Arabian Coast, 22°22′48″N., 60°06′24″E.; depth: 1948 m; bottom: soft green mud; bottom temperature (at 1910 m): 3·2°C; gear: triangular dredge; date: 6.11.1933.
**Cryptodon bisecta*
Abra profundorum

St. 62, Northern area of Arabian Sea, 22°53′30″ N., 64°56′10″E.; depth: 1893 m; bottom: grey clay; bottom temperature: 4·0°C; gear: Agassiz trawl; date: 18.11.1933.
Nucula donaciformis
Amussium meridionale
Abra profundorum

St. 66, Gulf of Oman, 23°44′24″N., 58°40′E.; depth: 609 m; bottom: soft brown green mud; bottom temperature: 12·3°C; gear: triangular dredge; date: 22.11.1933.

Pitar sewelli n. sp.

St. 77, South Arabian Coast, 22°13′30″N., 59°52′E.; depth: 411 m; bottom: grey mud; gear: grab; date: 30.11.1933.

Tellina coromandelica

St. 107, Zanzibar area, 5°15′30″S., 39°33′E.; depth: 421–457 m; gear: Agassiz trawl; date: 12.1.1934.

Cuspidaria macrorhynchus

St. 108, Zanzibar area, 5°18′06″S., 39°24′12″E.; depth: 786 m; bottom: grey mud; bottom temperature: 7·9°C; gear: Agassiz trawl; date: 13.1.1934.

Nucula bengalensis
**Acila divaricata*
Acar asperula
Amussium caducum
**Abra profundorum*
Poromya eximia
Cuspidaria approximata
Cuspidaria convexa

St. 109, Zanzibar area, 5°10′36″S., 39°33′48″E.; depth: 640 m; bottom: light grey mud; bottom temperature (at 627 m): 8·9°C; gear: Agassiz trawl; date: 13.1.1934.

Limopsis sansibarica
**Cuspidaria kawamurai*

St. 110, Zanzibar area, 5°03′42″S., 39°15′24″E.; depth: 347–384 m; bottom: grey, green mud, sand; bottom temperature (at 320 m): 12·9°C; gear: Otter trawl; date: 14.1.1934.

Xylophaga murrayi n. sp.

St. 118, Zanzibar area, 4°05′54″S., 41°10′12″E.; depth: 1789 m; bottom: globigerina ooze; bottom temperature: 3·0°C; gear: Agassiz trawl; date: 17.1.1934.

Amussium sewelli n. sp.

St. 119, Zanzibar area, 6°29′24″S., 39°49′54″E.; depth: 1207–1463 m; bottom temperature (at 1215 m): 6·2°C; gear: Agassiz trawl; date: 19.1.1934.

Amussium andamanicum
Lyonsiella murrayi
Euciroa eburnea

St. 120, Zanzibar area, 5°49′12″S., 41°28′12″E.; depth: 2926 m; bottom: brown mud over grey globigerina ooze; bottom temperature (at 2886 m): 2·2°C; gear: Agassiz trawl; date: 20.1.1934.

Limopsis pelagica
Amussium meridionale

St. 122, Zanzibar area, 5°21′24″S., 39°23′E.; depth: 732 m; bottom: grey green mud; bottom temperature (at 748 m): 8·3°C; gear: Otter trawl; date: 22.1.1934.

**Euciroa eburnea*

St. 124, Zanzibar area, 5°39′S., 39°39′24″E.; depth: 914 m; bottom: grey green mud, sand; bottom temperature: 6·9°C; gear: Monégasque trawl; date: 23.1.1934.

Amussium watsoni

St. 125, Zanzibar area, 5°36′12″S., 39°28′24″E.; depth: 805 m; bottom: light brown mud over grey clay; gear: grab; date: 23.1.1934.

**Lucina inanis*

St. 143, Maldive area, 5°15′48″S., 73°22′48″E.; depth: 797 m; bottom: grey sand; bottom temperature (at 770 m): 7·9°C; gear: Agassiz trawl; date: 30.3.1934.
Amussium jeffreysi
**Euciroa eburnea*

St. 145, Maldive area, 4°58′42″S., 73°16′24″E.; depth: 494 m; bottom temperature (at 400 m): 10·9°C; gear: Agassiz trawl; date: 2.4.1934.
Amussium jeffreysi
**Cuspidaria kawamurai*

St. 158, Maldive area, 4°42′30″N., 72°42′30″E.; depth: 786–1170 m; gear: Agassiz trawl; date: 7.4.1934.
Cuspidaria dubia
Cuspidaria macrorhynchus

St. 159, Maldive area, 4°47′30″N., 72°45′18″E.; depth: 914–1463 m; gear: Monégasque trawl; date: 7.4.1934.
**Euciroa crassa*

St. 162, Maldive area, 8°08′30″N., 72°58′E.; depth: 1829–2051 m; bottom: grey mud; gear: Agassiz trawl; date: 10.4.1934.
Amussium meridionale

St. 171, Central part of Arabian Sea, 9°07′06″N., 55°27′06″E.; depth: 3840–3872 m; gear: Agassiz trawl; date: 28.4.1934.
Abra profundorum

St. 176, Gulf of Aden, 12°04′06″N., 50°38′36″E.; depth: 655–732 m; bottom: green mud, sand; gear: Agassiz trawl; date: 2.5.1934.
Nuculana fumosa
Amussium jeffreysi
**Pecten alcocki*
**Myodora quadrata*
**Euciroa eburnea*

St. 177, Gulf of Aden, 12°01′54″N., 50°39′12″E.; depth: 274–366 m; bottom: green mud, rock; gear: Agassiz trawl; date: 2.5.1934.
**Pecten alcocki*
Venus juvenilis

St. 180, Gulf of Aden, 12°03′24″N., 50°40′12″E.; depth: 397 m; bottom: green mud, sand; gear: grab; date: 2.5.1934.
**Nuculana fumosa*
Venus juvenilis
**Tellina travancorica*

St. 185, Gulf of Aden, 13°48′06″N., 49°16′48″E.; depth: 2000 m; bottom: green mud; gear: Agassiz trawl; date: 5.5.1934.
Nucula donaciformis
Limopsis pelagica
Amussium andamanicum
Amussium meridionale
Abra profundorum
Cuspidaria macrorhynchu

St. 193, Gulf of Aden, 13°06′12″N., 46°24′30″E.; depth: 1061–1080 m; bottom: green mud; bottom temperature (at 1000 m depth): 10·9°C; gear: Agassiz trawl; date: 7.5.1934.
Amygdalum politum
Amussium caducum

St. 207, Red Sea, 14°08′56″N., 42°19′E.; depth: 375 m; bottom: green brown mud, pteropod shells; gear: grab; date: 16.5.1934.
Nucula donaciformis
**Amussium steindachneri*
**Cuspidaria brachyrhynchus*

Dr. Th. Mortensen's Pacific Expedition 1913-1916:

25 miles E. by S. of Zamboanga, Philippines; depth: 300–380 m; gear: Sigsbee trawl; date: 3.3.1914
Propeamussium sibogai

Off Tucuran, Philippines, 7°30′N., 123°30′E.; depth: 548 m; bottom: mud; gear: Sigsbee trawl; date: 10.3.1914.
Amussium caducum

The Danish Expedition to the Kei Islands 1922:

St. 7, Banda Sea, 5°38′30″S., 132°26′E.; depth: 196 m; bottom: sandy mud with small stones; gear: trawl; date: 5.4.1922.
**Cryptodon bisecta*

St. 29, Banda Sea, 5°38′S., 132°53′30″E.; depth: 430 m; bottom: mud; gear: trawl; date: 17.4.1922.
Acar asperula
Euciroa rostrata

St. 51, Banda Sea, 5°46′30″S., 132°51′E.; depth: 348 m; bottom: mud; gear: trawl; date: 7.5.1922.
Propeamussium sibogai
Myodora quadrata

St. 52, Banda Sea, 5°46′S., 132°49′35″E.; depth: 352 m; bottom: mud; gear: trawl; date: 7.5.1922.
Amygdalum politum
Tellina travancorica
Euciroa rostrata

St. 62, Banda Sea, 5°29′25″S., 132°50′E.; depth: 290 m; bottom: sand, shells, concretions; gear: trawl; date: 15.5.1922.
Euciroa rostrata

The Java-South Africa Expedition 1929-30:

St. 7, Bali Strait, 8°29′S., 114°40′E.; depth: 200 m; bottom: mud; gear: trawl; date: 5.4.1929.
Venus juvenilis

St. 15, off Java, 7°29′S., 114°49′E.; depth: 240 m; bottom: sand, mud, with concretions; gear: Sigsbee trawl; date: 10.4.1929.
Cuspidaria alcocki

St. 16, off Java, 7°35′S., 114°42′E.; depth: 200 m; bottom: mud; gear: Sigsbee trawl; date: 10.4.1929.
Euciroa rostrata

The "Galathea" Expedition 1950-52:

St. 196, off Durban, S. Africa, 29°55′S., 31°20′E.; depth: 430 m; bottom: sand, clay; gear: Petersen grab; date: 13.2.1951.
Propeamussium sibogai
Amussium jeffreysi

St. 202, off Natal, S. Africa, 25°20′S., 35°17′E.; depth: 575–595 m; gear: dredge, sledge trawl; date: 21.2.1951.
Euciroa eburnea
Cuspidaria caduca
Cuspidaria kawamurai

St. 302, Bay of Bengal, 19°42′N., 86°48′E.; depth: 1190 m; bottom: clay; gear: sledge trawl; date: 25.4.1951.
Nucula donaciformis
Amygdalum politum

St. 324, Strait of Malacca, 6°38′N., 96°00′E.; depth: 1140 m; bottom: brownish globigerina ooze; gear: sledge trawl; date: 9.5.1951.
Amussium watsoni

St. 423, off Cebu, Philippines, 10°27′N., 124°18′E.; depth: 750 m; bottom: green mud; gear: sledge trawl; date: 25.7.1951.
Pecten alcocki

St. 436, E. of Cebu, Philippines, 10°12′N., 124°14′E.; depth: 710 m; bottom: green mud; gear: sledge trawl; date: 9.8.1951.
Propeamussium sibogai
Amussium caducum
Pecten alcocki

St. 443, Mindanao Sea, 8°48′N., 124°09′E.; depth: 1500 m; bottom: mud, many fragments of plants; gear: sledge trawl, dredge; date: 16.8.1951.
Amygdalum politum
Amussium caducum
**Euciroa eburnea*

St. 453, Makassar Strait, 3°56′S., 118°26″E.; depth: 2000 m; bottom: greenish clay; bottom temperature (at 1952 m): 3·6°C; gear: sledge trawl; date: 24.8.1951.
Nucula donaciformis

St. 489, Bali Sea, 7°38′S., 116°08′E.; depth: 1160 m; bottom: dark clay; gear: sledge trawl; date: 13.9.1951.
Nucula bengalensis
Acila divaricata
Malletia conspicua

St. 490, Bali Sea, 5°25′S., 117°03′E.; depth: 545–570 m; bottom: sand and clay; gear: sledge trawl, dredge; date: 14.9.1951.
**Cuspidaria kawamurai*

St. 500, Arafuru Sea, 7°34′S., 132°44′E.; depth: 390 m; bottom: coral, sand and stones; gear: dredge; date: 25.9.1951.
Propeamussium sibogai

REMARKS ON THE DISTRIBUTION

The available data on the distribution and temperature range of the species treated in the present paper have been summarized in the form of Table 1. It should be noticed, however, that the information is far from complete, owing to the scarcity of earlier data concerning the individual species, with the result that both the depth and temperature ranges given in most cases are too small. Therefore the conclusions set forth here are highly provisional and are likely to be changed as more material becomes available.

The depths and temperature ranges given refer as far as possible to records of live specimens, depths given in brackets indicate other records ("dead shells").

TABLE 1

Species	Horizontal distribution	Vertical distribution m	Temperature range °C	Remarks	l-littoral a-abyssal b-bathyal
Nucula bengalensis	E. Africa (Zanzibar area) to N.E. Japan	(265)-786–1400	1·6-10		b
donaciformis	Red Sea, N. Indian Ocean, S.E. Asian waters	210–2000	3 to about 22		b
Acila divaricata	E. Africa (Zanzibar area), S.E. Asian waters, Japan Sea (to about 45°N.) E. of Japan	18–1046	2·8–20		l+b
Tindaria murrayi	Gulf of Aden	2312	2·7		a?
Malletia angulata	Bay of Bengal	(370) 521–741	—		b
conspicua	Arabian Sea, S.E. Asian waters	918–1165	4·2–5·2		b
Nuculana fumosa	Gulf of Aden, Bay of Bengal	265–732	10–12		b
Spinula filatovae	Gulf of Aden	2312	2·7		a?
Acar asperula	Atlantic, Indian and W. Pacific	430–5005	1–9		a (+b)
Limopsis pelagica	Atlantic, Indian and Pacific	2001–4990	1·1–3·4		a
sansibarica	E. coast of Africa (Zanzibar area), to Gulf of Aden	404–640 (1270?)	11·1		b
Amygdalum politum	Atlantic, Indian, S.W. Pacific	330 (possibly less)–1886	3·3–11·5		b
Propeamussium sibogai	E. Africa (from about 30°S.), Japan Sea, S.E. Japan	183–710	6·5–12		b
Amussium andamanicum	Indian Ocean	1207–2000	3·4–6·2		b
caducum	Arabian Sea (Mauritius), S.E. Asian waters, S.E. Japan to 35°N.	190–1500	5·2–11/12		b
jeffreysi	E. Africa (from about 30°S.), to S.E. Japan	290–797	8–12·5		b
meridionale	Indian Ocean, C. Pacific	1893–4810	1–4		a
sewelli	Zanzibar area	1789	3		b
steindachneri	Red Sea, Gulf of Oman	(256)–(457)	—	known from shells only	
watsoni	E. Africa (Zanzibar area), S.E. Asian waters, S.E. Japan	914–2160	2–6·9		b
Pecten alcocki	Indian Ocean, S.E. Asian waters	(274) 614–750 (1079)	7·3–12		b
Cryptodon bisecta	N.E. Pacific (Alaska to Oregon), Japan Sea, S.E. Japan, S.E. Asian waters, Indian Ocean, S. Africa	10–464 (1948?)	2·7–?	Pliocene of California, Miocene Oregon & Japan	l+b
Lucina bengalensis	Indian Ocean, S.E. Asian waters	(659) 750–(1415)	7·5		b
inanis	Zanzibar area, S.E. Asian waters	217–805	7–13·8		b

Species	Horizontal distribution	Vertical distribution m	Temperature range °C	Remarks	l-littoral a-abyssal b-bathyal
Pitar sewelli	Gulf of Oman	609	12·3		b
Venus juvenilis	Indian Ocean, S.E. Asian waters	200–397 (458)	10–15·5		
Abra profundorum	Atlantic, Indian and Pacific Oceans	835–5413	0·7–7·2		(b) a
Tellina coromandelica	Indian Ocean	243–1958	—	no information of live specimens	b
travancorica	Indian Ocean, S.E. Asian waters	(352)–(659)	—	no information of live specimens	b
Xylophaga murrayi	Zanzibar area	347–384	12·9		b
Myodora quadrata	E. Africa (Zanzibar area), to S.E. Japan	348–750	7·3–11		b
Lyonsiella murrayi	Zanzibar area	1207–1463	6·2		b
Euciroa crassa	E. Africa (Zanzibar area), to S.E. Japan	183–914–1463	—	no live specimens reported	b
eburnea	E. Africa (off Natal). S.E. Asian waters	340–1204	(3·3?) 6–11		b
rostrata	S.E. Asian waters, S.E. Japan	(230) 290–352 (470)	about 10		b
Poromya eximia	E. Africa (Zanzibar area), S.E. Asian waters	694–786	7·9		b
Cuspidaria alcocki	Red Sea, Indian Ocean, S.E. Asian waters	(73) 240–1134	7·6 to about 22		b
approximata	E. Africa (off Natal), N.E. Indian Ocean	(+6?) 400–786	7·9–11		b
brachyrhynchus	Red Sea	439–2160	(22)	no live specimens reported	—
caduca	E. Africa (off Natal), S. Japan	340–1134	7·6–13·3		b
dubia	Indian Ocean, S.E. Asian waters, S.E. Japan	786–1788	2–7		b
kawamurai	E. Africa (off Natal), S.E. Asian waters, S.E. Japan	575–595–740–1040	5–11·3		b
macrorhynchus	S.E. Africa (off Natal), S.E. Asian waters, S.E. Japan	220–918	5–10 (about 18?)		b
steindachneri	Red Sea and S.E. Japan	350–1082 (Red Sea) 106–183 (Japan)	to about 22		b

It appears from the table that the following four species are abyssal and widely distributed: *Acar asperula*, *Limopsis pelagica*, *Amussium meridionale* and *Abra profundorum*. The first and the last of these species have occasionally been found in the bathyal zone, but for both of them by far the most records are from depths greater than 2500 m. The question of the occasional occurrence of otherwise abyssal species in the bathyal zone will be discussed in a forthcoming publication. Two species (*Tindaria murrayi* and *Spinula filatovae*) both only recorded once, have been termed "abyssal" with some doubt, and have been included among the bathyal species in the following sections.

Of the remaining species those occurring in the Red Sea constitute a separate element: *Nucula donaciformis*, *Amussium steindachneri*, *Cuspidaria alcocki*, *C. steindachneri*. *Nucula donaciformis* is also known from live specimens taken in the Indian Ocean proper. This together with the Red Sea occurrence gives the species a remarkable temperature range. *Amussium steindachneri* is known both from the Red Sea and the Gulf of Oman, but until now, only from shells. *Cuspidaria alcocki* is known as live specimens both from the Red Sea and from off E. Africa, showing that the species like *Nucula donaciformis*, has a very large temperature range. *Cuspidaria brachyrhynchus* has been recorded only from the Red Sea.

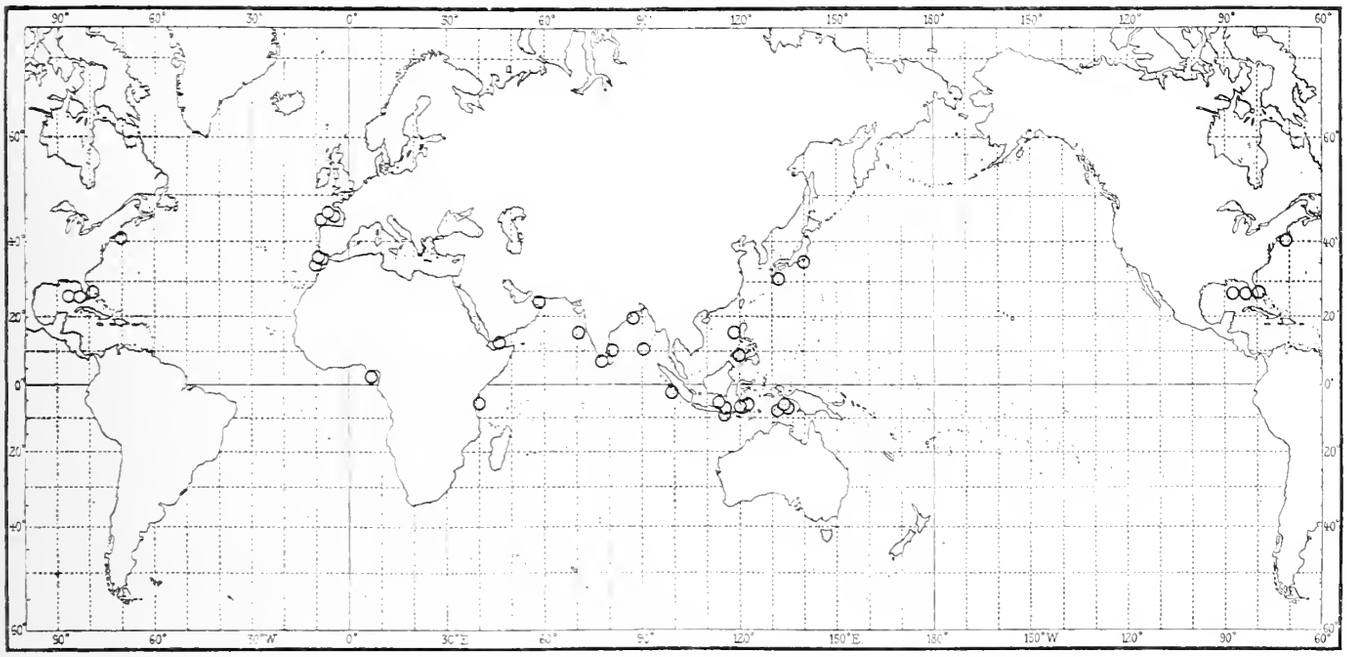


FIG. 38. Map showing the distribution of *Amygdalum politum* (Verrill & Smith).

Two of the bathyal species, viz., *Amygdalum politum* and *Cryptodon bisecta*, have a remarkable distribution.

The horizontal distribution of *Amygdalum politum* is shown on the map in fig. 38, which indicates that the species apparently has three widely separated areas of distribution, viz., the W. Atlantic (from about 25°N. to about 40°N.), E. Atlantic (from about 0° to about 45°N.) and the Indo–W. Pacific, from off E. Africa to off S.E. Japan. The numerous samples studied by the present author failed to show any difference in morphology between specimens from the three regions. Future investigations may show that the separation between the separate areas is simply due to lack of investigations, and that the species actually has a more or less continuous distribution extending from the W. Atlantic eastwards or westwards to the W. Pacific. A conspicuous feature in the distribution of the species is its apparent absence in the boreal and antiboreal seas in spite of the fact that the temperature requirements of the species should not prevent it from living there.

Cryptodon bisecta has a distribution ranging from off S. Africa (at about 17° E.), the Indian Ocean to the N. and N.E. Pacific (to about 45° N.). Besides, it is known as a fossil from Tertiary deposits in the W. part of N. America as far south as California.

Turning now to the remaining 32 species listed in the table, it appears that the following ten species have a known distribution extending from E. Africa (Natal region, about 30° S. or Zanzibar region at about 10° S.), throughout the Indian Ocean, S.E. Asian waters to Japan: *Nucula bengalensis*, *Acila divaricata*, *Propeamussium sibogai*, *Amussium jeffreysi*, *A. watsoni*, *Myodora quadrata*, *Euciroa crassa*, *Cuspidaria caduca*, *C. kawamurai*, *C. macrorhynchus*.

Two species, *Amussium caducum* and *Cuspidaria dubia*, extend from other parts of the Indian Ocean to the Japanese waters.

The remaining species have less extensive distributions, although the following ten species have been recorded from the western part of the Indian Ocean (E. Africa, Gulf of Aden, Gulf of Oman, Arabian Sea), extending to the S.E. Asian waters: *Nucula donaciformis*, *Malletia conspicua*, *Pecten alcocki*, *Lucina bengalensis*, *L. inanis*, *Venus juvenilis*, *Tellina travancorica*, *Poromya eximia*, *Cuspidaria alcocki*, *C. approximata*.

From this survey it appears that as far as bivalves are concerned it seems justified to speak about an Indo-West Pacific bathyal fauna, extending from E. Africa and having at least approximately the same extension as that of the adjacent shallow-water fauna (see Ekman (1953)). How far out into the Pacific this fauna element is found is unknown at present, and the same applies to the problem of a possible subdivision of this region into smaller natural units in the same way as Ekman (1953) did with the shallow-water fauna. On the other hand, it seems likely that an increased knowledge of the bivalve fauna and taxonomic revision of the known species, will no doubt increase the number of species found to be distributed throughout the whole area.

Turning now to the bathyal bivalve faunas of some neighbouring areas, those of the Tasman Sea and the New Zealand waters have been studied by Dell (1956, 1963). It appears that the New Zealand waters (and also the poorly known bathyal fauna off E. Australia), seem to have their own fauna extending as far north as to 35–37° S. A comparison of the species recorded in Dell's papers and in the present investigation failed to show any common species. The same applies to Verco's (1907, 1908) survey of a number of bivalves from bathyal depths in the Australian Bight. Barnard (1964a), in his survey of all known S. African bivalves, recorded some 13 bathyal species, of which three are also included in the present report: *Thyasira investigatoris* (=*Cryptodon bisecta*), *Cuspidaria approximata* and *C. macrorhynchus*, the distribution of which has already been discussed. The remaining ten species are not known from the Indo-West Pacific area.

Working out the vertical distribution of the present material, it turned out that there was some evidence that some bathyal species were found in more shallow depths in the Japanese waters than in the Indian Ocean–S.E. Asian waters. The data available appears in Table 2.

TABLE 2

	JAPANESE WATERS	INDIAN OCEAN/S.E. ASIAN WATERS
Nucula bengalensis	(492) 1190–1400	265–1135
Acila divaricata	18–350	(265) 463–1165
Amygdalum politum	91–146	73? 330–1886
Propeamussium sibogai	(146)–290	435–710
Amussium caducum	around 200	(462) 548–1500
jeffreysi	290–514	430–797
watsoni	2140–2160	914–1958
Cryptodon bisecta	10–770	196?–1464 (1948)
Myodora quadrata	(62)	348–750
Euciroa crassa	183–(300)	(818) 914–1463
Cuspidaria caduca	(84–325)	595–1134
kawamurai	740–1030	(411)–575
macrorhynchus	(106)–(177)	421

It should be stressed, however, that the data is admittedly very scanty. The best example would probably be *A. divaricata* of which a fair number of samples have been examined by the present author. It is also seen from the table that in three species, *Nucula bengalensis*, *Amussium watsoni* and *Cuspidaria kawamurai* the reverse situation is found.

From the survey of the temperature range of the species in Table 1 it appears, that the abyssal species occur at very low temperatures. Two species, *Acar asperula* and *Abra profundorum* have been found at temperatures up to 7·2° and 9°C respectively. However, by far the most records of these two species are from temperatures below 4°C, as is the case with the two other abyssal species, *Limopsis pelagica* and *Amussium meridionale*.

If we exclude the bathyal species occurring in the deep part of the Red Sea and in the littoral zone, the following survey shows the upper temperature limit observed in bathyal species of the present material:

Upper temperature limit 10·0 to 10·9° C – 2 species
,, ,, ,, 11·0 to 11·9° C – 6 species
,, ,, ,, 12·0 to 12·9° C – 6 species
,, ,, higher than 13·0° C – 3 species

As already mentioned the upper temperature limit of the bathyal fauna has often been put at around 10°C. The above survey would seem to indicate, that it should rather be put at 12°C, as suggested by Knudsen (1961). Table 1 would also indicate that the lower limit of the bathyal zone should not be put at about 4°C, several species occurring at still lower temperatures. However, no conclusion can be reached from the present material on this point.

FEEDING

The species of bivalves dealt with in the present paper represent the following different feeding types:

Abyssal species:

Deposit feeders: *Limopsis pelagica*, *Abra profundorum*.
Suspension feeder: *Acar asperula*.
Carnivore: *Amussium meridionale*.

Bathyal species:

Deposit feeders (9 species): *Nucula bengalensis*, *N. donaciformis*, *Acila divaricata*, *Tindaria murrayi*, *Malletia angulata*, *M. conspicua*, *Nuculana fumosa*, *Spinula filatovae*, *Limopsis sansibarica*.
Suspension feeders (9 species): *Amygdalum politum*, *Pecten alcocki*, *Cryptodon bisecta*, *Lucinoma bengalensis*, *Lucina inanis*, *Pitar sewelli*, *Venus juvenilis*, *Tellina coromandelica*, *T. travancorica*.
Borer (1 species): *Xylophaga murrayi*.
Carnivores (20 species): *Propeamussium sibogai*, *Amussium andamanicum*, *A. caducum*, *A. jeffreysi*, *A. sewelli*, *A. steindachneri*, *A. watsoni*, *Lyonsiella murrayi*, *Enciroa crassa*, *E. eburnea*, *E. rostrata*, *Poromya eximia*, *Cuspidaria alcocki*, *C. approximata*, *C. brachyrhynchus*, *C. caduca*, *C. dubia*, *C. kawamurai*, *C. macrorhynchus*, *C. steindachneri*.
Unknown (1 species): *Myodora quadrata*.

The number of abyssal species is too small to allow one to make generalizations on the relative frequency of the different feeding types. In dealing with the bathyal species it appears that the carnivores constitute about 50%, while the two other main groups, deposit feeders and suspension feeders, constitute some 23% each. It is of interest to compare these figures with those of Ockelmann (1958) which deal with the feeding types of bivalves in different areas and depths in the N. Atlantic. In the shelf region (< 400 m depth) Ockelmann found that the percentage of suspension feeders varied from 62 at E. Greenland to 77 along the S., W. and N.W. coasts of Iceland, the percentage of deposit feeders varied from 14 (S., W. and N.W. coasts of Iceland), to 28·5 (E. Greenland), while the percentage of carnivores varied from 4 (off the Faroes) to 9·5 (E. Greenland). In the bivalve faunas of deeper water Ockelmann found that in depths of 400–1000 m the percentage of suspension feeders decreased to 55·5, while the percentage of deposit feeders and carnivores increased to 29 and 15·5 respectively. This tendency was further accentuated in the bivalve fauna living below 1000 m depth. Here the percentage of suspension feeders decreased to 52, while the percentage of deposit feeders and carnivores increased to 34·5 and 13·5 respectively. It is quite evident from the above that at least in the N.W. part of the Indian Ocean, the percentage of carnivores is much higher than in any of the regions investigated by Ockelmann, but similar surveys from other parts of the world seem to be lacking.

A characteristic feature of the present material is that several of the carnivores are relatively large species; this applies, for instance, to *Propeamussium sibogai*, *Amussium andamanicum*, *A. sewelli*, the three species of *Euciroa* and some of the *Cuspidaria* spp. It could be that to some extent the dominance of the carnivores found is due to the collecting technique of the expedition, smaller species (Protobranchia and other deposit feeders are generally much smaller than the carnivores listed), tending to escape through the meshes of the sampling equipment used, while larger species (with a relative dominance of carnivores) have been retained. However, there can be little doubt that in the region dealt with here, relatively large carnivorous bivalves play an important role in the ecology of the bathyal zone and that this zone must support a relatively rich meiobenthos in order to sustain these bivalves. In this connection it is of interest to note that Hessler & Sanders (1966) observed a considerable diversity of the benthic fauna of the N.W. Atlantic deep-sea, the number of organisms (of which a large proportion should be classified as meiobenthos) in certain places as being high as approximately 25,000 in one dredge haul. Hessler & Sanders conclude that "high faunal diversity is characteristic of deep-sea assemblages" , and "the deep-sea is not the harsh environment that it has generally been assumed to be". Thiel (1966) studied the meiofauna at eight localities (12 samples) from off Somali, E. Africa at depths ranging from about 1000 to about 5000 m. The number of animals found varied between 16 and 170 per 10 cm^2. The samples were dominated by Nematoda, constituting between 63 and 97% of the total number of specimens, but Crustaceans (particularly Harpacticoida, Nauplia and Ostracoda) were quite frequent also. The total number of animals found appeared to be equal to that found in many shallow water localities (although considerable higher numbers have been found in some of the latter). It is concluded that the nourishment condition of the deep sea macrofauna seems to be more favourable than hitherto assumed.

While the food uptake of the Septibranchia (of which group, as far as it is known, all members are carnivores) has been studied in detail (Yonge, 1928), nothing is known about the feeding mechanism of the carnivorous *Amussium* species. Yonge (1928) found by observations on live material of *Cuspidaria* spp. and *Poromya* sp. that water and food (small crustaceans and annelids) are drawn into the mantle cavity as a result of regular movements of the septum, the food items being pushed into the mouth by the muscular labial palps. A similar pumping function might be present in the carnivorous *Amussium* spp. in their capture of food, viz., the vigorous movements of the shells ("swimming movements") in connection with a closing of the mantle cavity by means of the very well-developed velum. In this connection it should be noted that the "quick" part of the adductor muscles is very large in all the species examined and the efficiency of this muscle is further increased by its oblique position (the right insertion being located much more dorsally than the left one). Yonge (1936) suggested that the swimming habit in the Pectinidae evolved from the cleansing mechanism. If the capture of food of the carnivorous *Amussium* spp. takes place in the way suggested here, this means a further development which may be described as follows: Cleansing mechanism → Swimming → Food Capture.

The food uptake and sorting in the carnivorous *Amussium* spp. must be a very efficient one since it was generally found that the stomach content was completely free from bottom sediments, although a small fish scale and a hydrotheca probably were ingested by accident. Frequently, however, a few sand grains were found in the stomachs; this was also observed by Yonge (1928) in the Septibranchia, suggesting that they may assist in the mechanical breaking up of the food. The Foraminifera observed in some of the *Amussium* stomachs may serve the same purpose. The question of whether the food items of the carnivorous *Amussium* are bottom-living or pelagic forms is of some interest. According to T. Wolff (personal communication) both seem to occur in the same specimen, indicating that food is captured both when the animal is resting on the bottom (but still moving the valves) and during swimming.

In order to see whether a carnivorous habit was found in all species of *Amussium* or perhaps restricted to deep-sea forms only, two specimens of *A. pleuronectes L.* (collected October 1959, off

Nhatrang, S. Vietnam at about 10 m depth by the present author), were examined. The stomach content was found to be completely different from that of the deep-sea *Amussium* and was obviously the type of stomach content found in typical suspension-feeding bivalves (such as other species of pectinids). Thus within the genus *Amussium* two widely different feeding types are found. In this connection attention should be called to the observation by Atkins (1938) which states that in *A. pleuronectes* the gills were plicate and heterorhabdic, thus differing in structure from those of a number of deep-sea *Amussium* examined by Ridewood (1903), (*A. dalli*, *A. meridionale* and *A. lucidum*) in which the gill lamellae are flat and homorhabdic. In this respect *A. pleuronectes* agrees with the species of *Pecten*. By examining *A. pleuronectes* the present author found some conspicuous anatomical differences from the deep-sea *Amussium*. They can be summarized as follows:

A. pleuronectes	Deep-sea *Amussium*
Labial palps large, flat, separate "striated area" relatively large.	Labial palps cup-shaped, small and joined, "striated area" small.
Eyes present.	Eyes absent.
Tentacles on velum.	No tentacles on velum.
Gills plicate, heterorhabdic (Atkins, 1938).	Gills flat, homorhabdic (Ridewood, 1903).

The two large species of *Amussium* (*A. pleuronectes*, *A. sibogai*) occur in the same area, although in different depth zones. With their widely different feeding habits and conspicuous anatomical differences, these would certainly be a most rewarding subject for a future investigation.

REPRODUCTION

Ockelmann (1965) gave a survey of the developmental types within the shallow-water bivalves of the N.E. Atlantic based on examination of egg size and prodissoconchs of more than 200 species. It turned out that in most marine bivalves the type of development could be determined, if either the ripe eggs or the prodissoconch was available for study. The following three types of development, which are probably of wide applicability, were found:

1. *Planktotrophic larval development:* The diameter of the ripe egg varies between 40 and 85 μ (with very little intraspecific variation). From the egg a pelagic veliger larva is developed, which in the beginning subsists exclusively on the yolk. The larval shell formed during this period is termed prodissoconch I. At a certain stage, feeding on phytoplankton begins, at which time another larval shell, prodissoconch II, is formed. The two larval shells are generally easily distinguished. The size of prodissoconch I ranges between 70 and 150 μ in diameter, again with very little intraspecific variation, while the size of prodissoconch II may vary between 200 and 600 μ.

2. *Lecithotrophic development with a short pelagic larval stage:* In this group the diameter of the ripe egg ranges from 90 to 140 μ and that of the prodissoconch ranges from 135 to 230 μ, both stages with a narrow intraspecific variation. The pelagic life is short, lasting from a few hours to a few days. No (or very little) feeding takes place during the pelagic life. The prodissoconch II is confined to a narrow zone along the edge of prodissoconch I or it is completely absent.

3. *Direct development:* The diameter of the ripe egg varies between 150 and 200 μ, the embryonic shell measures 230 to 500 μ (sometimes even larger), both characters showing a rather large intraspecific variation. In the embryonic shell both prodissoconch I and II are well developed and easily separated.

In the present material ripe eggs and/or embryonic shells were available in 32 of the 44 species dealt with. The measurements of eggs and embryonic shells were made from enlarged outline drawings, and whenever possible, 5–10 eggs were measured. The measurements of eggs, and embryonic shells (in μ), are in Table 3.

TABLE 3

SURVEY OF TYPES OF REPRODUCTIVE DEVELOPMENT

a-abyssal; b-bathyal.

	Egg size	Prod.	Distribution type	Reproductive type
Nucula bengalensis	200	300	b	Direct
donaciformis	—	220	b	Lecithotrophic
Acila divaricata	150–160	230	b	Lecithotrophic
Tindaria murrayi	—	185	b	Lecithotrophic
Malletia angulata	—	—	b	?
conspicua	—	400	b	Direct
Nuculana fumosa	—	580–660	b	Direct
Spinula filatovae	—	—	b	?
Acar asperula	150	250	a+(b)	Lecithotrophic
Limopsis pelagica	135	200	a	Lecithotrophic
sansibarica	—	200	b	Lecithotrophic
Amygdalum politum	60–70	400	b	Planktotrophic
Propeamussium sibogai	160–180	210	b	Lecithotrophic
Amussium andamanicum	—	250	b	Lecithotrophic
caducum	150	215	b	Lecithotrophic
jeffreysi	110–140	210	b	Lecithotrophic
meridionale	—	200	a	Lecithotrophic
steindachneri	—	200	—	?
watsoni	—	—	b	?
Pecten alcocki	—	280	b	Lecithotrophic
Cryptodon bisecta	—	—	b?	?
Lucina bengalensis	—	—	b	?
inanis	—	215	b	Lecithotrophic
Pitar sewelli	—	225–250		Lecithotrophic
Venus juvenilis	50–60	250–275	b	Planktotrophic
Abra profundorum	55–65	275	a+(b)	Planktotrophic
Tellina coromandelica		220–240	b	Lecithotrophic
travancorica	—	—	b	?
Xylophaga murrayi	—	330 (embryo)	b	
Myodora quadrata		190–215	b	Lecithotrophic
Lyonsiella murrayi	120–150	—	b	Lecithotrophic
Euciroa crassa	—	—	b	?
eburnea	—	350	b	
rostrata	300	330	b	Direct
Poromya eximia	140	—	b	Lecithotrophic
Cuspidaria alcocki	—	—	b	?
approximata	—	—	b	?
caduca	125–135	155	b	Lecithotrophic
dubia	180	—	b+(a)	Direct
kawamurai	185–200	—	b	Direct
macrorhynchus	—	—	b	?

Considering now the four abyssal species which were available for examination, it appears that three (*A. asperula*, *L. pelagica* and *A. meridionale*) have lecithotrophic development with a very short pelagic stage. The fourth abyssal species, *A. profundorum* has the characteristics of a planktotrophic development both as regards egg-size and the size of the prodissoconch. *A priori* the conditions in the abyssal zone would seem to be extremely unfavourable to that type of development. Dr. Ockelmann (personal communication) has suggested the possibility of the larvae of *A. profundorum* ascending to the surface for feeding and later descending for metamorphosis – a vertical movement of up to 5000 m. If this should really prove to be the case it might explain the very wide distribution of this species and also the very small intraspecific variation observed. A closer examination of this question would be highly interesting.

However, the number of abyssal species available in the present material is small, and a closer and more detailed consideration of the reproduction of the abyssal bivalves is planned in conjunction with a study of the bivalves of the "*Galathea*" *expedition* now in progress.

Turning then to the bathyal species, information on reproduction could be obtained from 26 species with the following result:

Type of development	Planktotrophic	Lecithotrophic	Direct	Total
Number	2	15	9	26
%	8	58	34	100

It appears, that in the bathyal species planktotrophic development has been observed in the two species *A. politum* and *V. juvenilis*. The former is of special interest since it has a very wide distribution (see p. 325), with apparently no intraspecific variation whatsoever. The lecithotrophic type of development is dominant, while direct development is found in only nine cases, including the brood-protecting *X. murrayi*. As regards the latter it is of some interest that Knudsen (1961) observed brood protection in nine species of *Xylophaga* from bathyal and abyssal depths, the juveniles being attached in most cases to the dorsal part of the shell of the female.

Comparing different shelf regions Ockelmann (1965) found that proceeding from south to north the proportion of bivalve species with lecithotrophic and direct development increased gradually. Thus, for instance, the Gibraltar-Arcachon region had 6–8% of the bivalve species with direct development, and 16–18% with lecithotrophic development. The Spitzbergen area had some 33% with direct development and some 35% with lecithotrophic development. Ockelmann also found, that in deeper water in the N.E. Atlantic (Northern North Sea, Skagerak and Kattegat), there is an increase in the proportion of the species having lecithotrophic development, increasing from 12% in 0–40 m depth to some 46% in the 200–400 m zone and some 66% at depths greater than 400 m. The proportion of species with direct development shows a much smaller increase ranging from some 10% from 0–200 m depth and increasing to 18–20% at greater depths. From this Ockelmann puts forwards the suggestion that in the deep-sea bivalves the lecithotrophic development with a short pelagic stage will be the predominating type of reproduction, whereas the direct development will be rare and brood protection even more so. Although it only deals with a small number of species the present investigation has confirmed this suggestion.

Among the species dealt with here hermaphroditism has been observed in the following species (all belonging to the Septibranchia): *P. murrayi*, *E. rostrata*, *P. eximia*. Pelseneer (1911) observed hermaaphroditism in the latter species and in *Eucirora eburnea*.

It should finally be noted, that, apart from *X. murrayi* no other case of brood protection has been observed in the present material in spite of the fact that the soft parts of very many specimens have been examined.

SURVEY OF THE DEEP-SEA BIVALVES OF R.I.M.S. "*INVESTIGATOR*", ARRANGED ACCORDING TO STATIONS

* designates type locality.

St. III, Bay of Bengal, 20°49′N., 89°08′E.; depth: 748 m; bottom: green ooze, pteropods; bottom temperature: 8·3°C; date: 1885.

Nucula (*Acila*) *fultoni* E. A. Smith (=*Acila divaricata*).

St. 1, Bay of Bengal, 21°6′30″N., 89°20′E.; depth: 521–741 m; bottom: green mud, pteropod ooze; date: 25.3.1885.

Yoldia angulata Sowerby (=*Malletia angulata*).

St. 2, off S.W. Coast of Ceylon, 6°32′N., 79°37′E.; depth: 1234 m; bottom: green mud; date: 5.5.1886.

**Scrobicularia ceylonica* E. A. Smith

Tellina parvula E. A. Smith (=*T. coromandelica*)

St. 9, Andaman Sea, S. by W. of N. Sentinel I.; depth: 238–457 m; date: 7.2.1888.

**Lyonsia jucunda* E. A. Smith

St. 10, Andaman Sea, 7·5 miles E. of N. Cinque I.; depth: 896 m; date: 12.4.1888.

Amussium caducum E. A. Smith

St. 102, Bay of Bengal, 15°38′N., 82°30′E.; depth: 1258–1687 m; bottom: brown mud; bottom temperature: 4·3°C; date: 1.4.1890.

**Amussium andamanicum* E. A. Smith

St. 105, Arabian Sea, 15°2′N., 72°34′E.; depth: 1353 m; bottom: grey ooze, globigerina ooze; bottom temperature: 6·7°C; date: 5.5.1890.

**Amussium alcocki* E. A. Smith (=*A. watsoni*)

St. 110, Bay of Bengal, 9°34′N., 85°43′15″E.; depth: 3652 m; bottom: globigerina ooze; bottom temperature: 1·7°C; date: 3.11.1890.

Poromya tornata (Jeffreys)

St. 111, Bay of Bengal, 12°50′N., 90°52′E.; depth: 3007 m; bottom: globigerina ooze; bottom temperature: 1·9°C; date: 6.11.1890.

Arca pteroessa E. A. Smith (=*Acar asperula*)

St. 112, Bay of Bengal, 13°47′30″N., 92°36′E.; depth: 1026 m; bottom: grey mud; bottom temperature: 7·2°C; date: 7.11.1890.

Amussium alcocki E. A. Smith (=*A. watsoni*)

Abra maxima (Sowerby) (?=*A. profundorum*)

St. 115, Andaman Sea, 11°31′40″N., 92°46′06″E.; depth: 344–402 m; bottom: green mud; bottom temperature 13·3°C; date: 9.12.1890.

**Euciroa eburnea* (Wood-Mason & Alcock)

**Cuspidaria* (*Myonera*) *caduca* E. A. Smith

St. 116, Andaman Sea, 11°25′05″N., 92°47′06″E.; depth: 741 m; bottom: green mud; bottom temperature: 8·3°C; date: 9.12.1890.

**Cuspidaria approximata* E. A. Smith.

St. 118, Bay of Bengal, 12°20′N., 85°08′E.; depth: 3297 m; bottom: globigerina ooze; bottom temperature: 1·7°C; date: 15.12.1890.

**Amussium solitarium* E. A. Smith

St. 127, Arabian Sea, off Minikoi I.; depth: 2195 m; bottom: globigerina ooze, coral; date: 12.12.1891.

Limopsis indica E. A. Smith (=*L. pelagica*)

St. 130, Bay of Bengal, off Godaveri Delta; depth: 472–514 m; bottom: brown mud; bottom temperature: 10·6°C; date: 23.1.1892.

**Yoldia anatina* E. A. Smith

St. 131, Bay of Bengal, 16°01′N., 81°25′E.; depth: 750 m; bottom: brown mud; Bottom temperature: 7·5°C; date: 21.2.1892.

Amussium caducum E. A. Smith

**Lucina bengalensis* E. A. Smith

St. 133, Bay of Bengal, 15°43′30″N., 81°19′30″E.; depth: 1240 m; bottom: brown mud, clay; bottom temperature: 5·6°C; date: 1.4.1892.

Modiola watsoni E. A. Smith (=*Amygdalum politum*)

Abra maxima (Sowerby) (?=*A. profundorum*)

St. 135, Arabian Sea, 15°29′N., 72°41′E.; depth: 1022 m; bottom: green mud; bottom temperature: 8·3°C; date: 4.5.1892.

Amussium jeffreysi E. A. Smith

Amussium caducum E. A. Smith

St. 144, Arabian Sea, 15° 05′ 06″N., 72°48′10″E.; depth: 315 m; bottom: sand; date: 19.10.1893.

Modiola watsoni E. A. Smith (=*Amygdalum politum*)

St. 151, W. of Ceylon, 13·5 miles N., 64° W. of Colombo Lt.; depth: 260–732 m; bottom: brown mud; date: 4.12.1893.

Solenomya patagonica E. A. Smith (=*grandis* Prashad 1932b)

**Limopsis indica* E. A. Smith

**Cryptodon investigatoris* E. A. Smith (=*C. bisecta*)

**Cardium simillimum* E. A. Smith

St. 162, Bay of Bengal, 13°51′12″N., 80°28′12″E.; depth: 265–457 m; bottom: brown mud; date: 30.1.1894.

**Nucula bengalensis* E. A. Smith

**Nucula donaciformis* E. A. Smith

Nucula (*Acila*) *fultoni* E. A. Smith (=*Acila divaricata*)

**Nuculana fumosa* E. A. Smith

**Nuculana indica* E. A. Smith (=*N. fumosa*)

**Venus juvenilis* E. A. Smith

St. 166, Bay of Bengal, 13°34′55″N., 80°32′12″E.; depth: 243 m; bottom: brown mud; bottom temperature: 12·7°C; date: 8.2.1894.

**Tellina parvula* E. A. Smith (=*T. coromandelica*)

St. 172, N.E. of Ceylon, 8°40′10″N., 81°17′45″E.; depth: 366–640 m; bottom: green mud; bottom temperature: 9·9–11·7°C; date: 26.3.1894.

**Abra convexior* E. A. Smith

Cryptodon philippinarum Hanley

Lucina spinifera (Mont.)

St. 173, N.E. of Ceylon, 8°35′45″N., 81°17′45″E.; depth: 1114 m; bottom: brown mud; bottom temperature: 6·7°C; date: 30.3.1894.

**Cryptodon acuticarinatus* E. A. Smith

Cryptodon investigatoris E. A. Smith (=*C. bisecta*)

Lucina bengalensis E. A. Smith (U.S. National Museum)

St. 176, Laccadive Sea, 11°47′06″N., 73°57′30″E.; depth: 1957 m; bottom: green mud; bottom temperature: 3·1°C; date: 4.5.1894.

**Lima subtilis* E. A. Smith

Tellina parvula E. A. Smith (=*T. coromandelica*)

St. 177, Laccadive Sea, 13°47′49″N., 73° 07′E.; depth: 1165 m; bottom: green mud; bottom temperature: 6·3°C; date: 5.5.1894.

**Malletia conspicua* E. A. Smith

**Cuspidaria macrorhynchus* E. A. Smith

**Myonera bicarinata* E. A. Smith

St. 192, Arabian Sea, 15°11′N., 72°28′45″E.; depth: 1668–1703 m; bottom: grey ooze; bottom temperature: 4·2–4·6°C; date: 14.1.1895.

Amussium andamanicum E. A. Smith

St. 197, Laccadive Sea, 9°34′57″N., 75°36′30″E.; depth: 743 m; bottom: green mud; bottom temperature: 8·9°C; date: 20.1.1895.

Dosinia salebrosa Römer

St. 219, S.W. of Ceylon, 6°59′30″N., 79°33′E.; depth: 971 m; bottom: green mud; bottom temperature: 7·2°C; date: 24.10.1896.

Amussium caducum E. A. Smith

St. 222, Andaman Sea, 13°27′N., 93°14′30″E.; depth: 741 m; bottom: green mud, ooze; bottom temperature: 8·9°C; date: 21.12.1896.

Vesicomya indica E. A. Smith

Abra maxima (Sowerby)

St. 229, Laccadive Sea, 9°29′34″N., 75°38′E.; depth: 658 m; bottom: green mud; bottom temperature: 9·2°C; date: 16.10.1896.

Nucula fultoni E. A. Smith (=*A. divaricata*)

Limopsis indica E. A. Smith

**Vesicomya indica* E. A. Smith

Lucina bengalensis E. A. Smith

**Tellina travancorica* E. A. Smith

**Myodora quadrata* E. A. Smith

Euciroa eburnea (Wood-Mason & Alcock)

St. 232, Laccadive Sea, 7°17′30″N., 76°54′30″ E.; depth: 786 m; bottom: grey mud; bottom temperature: 3·3°C; date: 19.10.1897.

Pecten alcocki E. A. Smith

**Arca* (*Barbatia*) *incerta* E. A. Smith

Lima indica E. A. Smith

Euciroa eburnea (Wood-Mason & Alcock)

St. 233, Andaman Sea, 13°17′15″N., 93°10′25″E.; depth: 338 m; bottom: sand; bottom temperature: 11·9°C; date: 6.12.1897.

Myrina indica E. A. Smith

Xylophaga indica E. A. Smith

Myodora quadrata E. A. Smith

St. 234, Andaman Sea, 13°15′30″N., 93°26′E.; depth: 911 m; bottom: green mud; bottom temperature: 8·2°C; date: 21.12.1897.

**Abra affinis* E. A. Smith

St. 240, Andaman Sea, 11°32′N., 92°46′E.; depth: 355 m; date: 16.4.1898.

Modiola watsoni E. A. Smith (=*Amygdalum politum*)

Anatina andamanica E. A. Smith

St. 248, Laccadive Sea, 8°37′N., 75°37′30″E.; depth: 410–519 m; bottom: sand; bottom temperature: 12·2–11·1°C; date: 17.10.1898.

**Amussium investigatoris* E. A. Smith

St. 249, Laccadive Sea, 7°N., 76°36′15″E.; depth: 1869 m; bottom: green mud, globigerina ooze; bottom temperature: 2·8°C; date: 18.10.1898.

Limopsis indica E. A. Smith (=*L. pelagica*)

St. 259, Laccadive Sea, 10° 08′43″N., 75°33′30″E.; depth: 540–658 m; bottom: green mud, sand; date: 17.1.1900.

Nucula donaciformis E. A. Smith

**Vesicomya brevis* E. A. Smith

Tellina travancorica E. A. Smith

St. 260, Laccadive Sea, 8°28′15″N., 76°07′E.; depth: 891 m; bottom: green mud, globigerina ooze; date: 18.1.1900.

**Solenomya patagonica* E. A. Smith (=*S. grandis* Prashad, 1932b)

St. 261, Laccadive Sea, 8°10′N., 76°26′E.; depth: 706–813 m; bottom: green mud, sand; date: 18.1.1900.
Lucina bengalensis E. A. Smith

St. 263, E. of Ceylon, 8°56′N., 81°09′E.; depth: 1216–1410 m; bottom: soft green mud, sand; date: 27.1.1900.
Abra maxima (Sowerby) (?=*A. profundorum*)

St. 265, Bay of Bengal, 9°32′N., 80°59′30″E.; depth: 412–1086 m; bottom: green mud; date: 29.3.1900.
Modiola (*Amygdalum*) *watsoni* E. A. Smith (=*A. politum*)
Abra affinis E. A. Smith
Abra maxima (Sowerby) (?=*A. profundorum*)

St. 267, W. of Ceylon, 7°02′30″N., 79°36′E.; depth: 836–1077 m; bottom: green mud, sand; date: 9.4.1900.
Modiola (*Amygdalum*) *watsoni* E. A. Smith (=*A. politum*)

St. 269, Laccadive Sea, 8°09′N., 76°30′E.; depth: 849 m; bottom: green mud, sand; date: 11.4.1900.
Limopsis indica E. A. Smith
Amussium caducum E. A. Smith

St. 275, Laccadive Sea, 8°27′N., 75°35′E.; depth: 1337–1410 m; bottom: green mud; date: 4.1.1901.
Amussium alcocki E. A. Smith (=*A. watsoni*)

St. 276, Laccadive Sea, 7°11′N., 76°35′30″E.; depth: 1840 m; bottom: green mud; bottom temperature: 1·9°C; date: 5.1.1901.
Lyonsiella papyracea E. A. Smith

St. 280, Bay of Bengal, 11°29′45″N., 80°02′30″E.; depth: 816 m; bottom: mud, sand; date: 19.3.1901.
Nucula bengalensis E. A. Smith

St. 289, Gulf of Oman, 23°56′45″N., 58°34′E.; depth: 1220–1483 m; bottom: green mud, clay; bottom temperature: 6·7°C; date: 30.10.1901.
Amussium caducum E. A. Smith

St. 297, Gulf of Oman, 25°11′30″N., 57°15′E.; depth: 1260–1280 m; bottom: soft green mud; bottom temperature: 6·7°C; date: 13.4.1902.
Amussium caducum E. A. Smith

St. 299, Arabian Sea, 23°43′N., 58°51′30″E.; depth: 2376 m; bottom: soft green mud; bottom temperature: 2·2°C; date: 16.4.1902.
Abra maxima (Sowerby) (=*A. profundorum*)

St. 301, Arabian Sea, 24°37′30″N., 62°02′30″E.; depth: 1829 m; bottom: green clay; bottom temperature: 5·0°C; date: 18.4.1902.
Abra maxima (Sowerby) (=*A. profundorum*)

St. 309, Andaman Sea, 10°09′N., 93°15″E.; depth: 1399 m; bottom: green mud; bottom temperature: 5·5°C; date: 31.10.1902.
Limopsis indica E. A. Smith

St. 310, Andaman Sea, 13°29′30″N., 95°29′E.; depth: 1756 m; bottom: mud; bottom temperature: 4·8°C; date: 5.11.1902.
Limopsis indica E. A. Smith

St. 316, S. of Ceylon, 5°43′30″N., 80°05′30″E.; depth: 2743 m; bottom: green mud; bottom temperature: 1·7°C; date: 17.4.1903.
Arca (*Barbatia*) *pteroessa* E. A. Smith (=*Acar asperula*)

St. 318, W. of Ceylon, 7°28′N., 79°19′30″E.; depth: 1985 m; bottom: green mud, globigerina ooze; bottom temperature: 2·7°C; date: 24.4.1903.

**Malletia brevis* E. A. Smith

Vesicomya cretacea E. A. Smith

St. 321, S. of Ceylon, 5°04′08″N., 80°22′E.; depth: 1207 m; bottom: green mud, globigerina ooze; date: 15.11.1903.

Abra maxima (Sowerby)

St. 322, Andaman Sea, 11°26′30″N., 92°53′43″E.; depth: 691 m; bottom: green mud, globigerina ooze; date: 20.11.1903.

Amussium caducum E. A. Smith

Amussium manaricum E. A. Smith

Cuspidaria approximata E. A. Smith

St. 323, Bay of Bengal, 16°25′N., 93°43′30″E.; depth: 847 m; bottom: green mud; bottom temperature: 1·8°C (?); date: 21.12.1903.

Lucina bengalensis E. A. Smith

St. 324, Bay of Bengal, 18°00′15″N., 93°30′45″E.; depth: 819 m; bottom: green mud; bottom temperature: 6·7°C; date: 22.12.1903.

**Nucula granulata* E. A. Smith

St. 327, Bay of Bengal, 17°07′30″N., 94°05′30″E.; depth: 767 m; bottom: green mud; bottom temperature: 12·4°C; date: 5.3.1904.

Solenomya patagonica E. A. Smith (=*S. grandis* Prashad, 1932b)

Amussium caducum E. A. Smith

**Vesicomya cretacea* E. A. Smith

Abra maxima (Sowerby)

St. 333, S.W. of Ceylon, 6°31′N., 79°38′45″E.; depth: 733 m; bottom: soft green mud; date: 19.4.1904.

Arca (*Barbatia*) *incerta* E. A. Smith

**Amussium manaricum* E. A. Smith

St. 336, S. of Cape Comorin, 7°37′15″N., 76°41′E.; depth: 1103 m; bottom: green mud, globigerina ooze; date: 26.4.1904.

Cryptodon investigatoris E. A. Smith (=*C. bisecta*)

St. 337, Laccadive Sea, 9°43′N., 75°35′E.; depth: 496 m; bottom: soft green mud, fine sand; date: 27.4.1904.

Tellina travancorica E. A. Smith

St. 340, Gulf of Oman, 23°44′30″N., 58°52′15″E.; depth: 477 m; bottom: green mud, sand; bottom temperature: 15·5°C; date: 17.10.1904.

Modiola (*Amygdalum*) *watsoni* E. A. Smith (=*A. politum*)

St. 341, Gulf of Oman, 23°47′N., 58°30′30″E.; depth: 421 m; bottom: green mud, sand; date: 18.10.1904.

**Crassatellistes omanensis* E. A. Smith

**Cryptodon omanensis* E. A. Smith

Meretrix (*Caryatis*) *pudicissisima* E. A. Smith

Without locality:

Limopsis indica E. A. Smith – 1408–1756 m – E. A. Smith 1904

Limopsis indica E. A. Smith – 1930 m – E. A. Smith 1906

St. No. not found:

Bay of Bengal, 6°29′N., 79°34′E.; depth: 1092 m.

**Cuspidaria* (*Cardiomya*) *alcocki* E. A. Smith

REMARKS ON THE DEEP-SEA BIVALVES OF THE R.I.M.S. "*INVESTIGATOR*"

As already mentioned on p. 240 the bivalve material of the "*Investigator*" *expedition* was published in a large number of papers by Wood-Mason & Alcock, E. A. Smith, Bavay & Sowerby. The information regarding locality, depth, temperature and the bottom, contained in these papers is rather incomplete and inconsistent. Thus in some cases only, area (for instance "Bay of Bengal") and depth are given, in other cases, only the position but not the depth is given, and sometimes the same record of a species appears in two or more of the papers mentioned. This makes it difficult to obtain a real idea of the stations worked, the species obtained at the individual stations, and the distribution of the species.

For this reason I have attempted to give a survey of the "*Investigator*" deep-sea bivalves arranged according to station, giving the complete data of the latter, based on the "*Investigator*" station list p. 331. The specific names are those used in the original paper, while the names used in the present paper and by Winckworth (1940) have been added in brackets. The list probably still contains some inaccuracies; a few findings could not be referred to any station but have nevertheless been listed. The list also contains a few records of museum samples seen by the present author, but not included in any paper dealing with the "*Investigator*" material. Altogether, 54 species were obtained at depths greater than 400 m and of these, 42 were described as new. In many cases the descriptions were accompanied by one or several figures and subsequently 36 species were figured in the "*Illustrations of the Zoology of the R.I.M.S. 'Investigator'*". However, the following species apparently have not been illustrated: *Malletia brevis*, *Amussium investigatoris*, *A. manaricum*, *Vesicomya cretacea*, *Cryptodon omanensis*, *Crassatellistes omanensis*, *Lyonsia jucunda*.

In the list it has not been possible to disinguish between "live specimens" and "shells". The "Agassiz" trawl was used at all the stations listed, except St. 1 and 2, where the "Blake" trawl was employed. At St. I and III no indication of gear is available.

TABLE 4

Species	Area	Depth range m	Temperature range °C	Bottom sediment	abyssal a bathyal b
Nucula bengalensis	Bay of Bengal	265–816	—	brown mud, sand	b
donaciformis	Laccadive area, Bay of Bengal	265–658	—	brown and green mud, sand	b
fultoni (= *A. divaricata*)	Laccadive area, Bay of Bengal	265–748	8·3–9·2	brown and green mud	b
granulata	Bay of Bengal	819	6·7	green mud	b
Solemya patagonica (= *grandis* Prashad 1933)	Laccadiva area, Ceylon area, Bay of Bengal	260–891	12·4	brown and green mud, globigerina ooze	b
Malletia brevis	Ceylon area	1985	2·7	green mud, globigerina ooze	(a)
conspicua	Laccadive area	1165	6·3	green mud	b
Yoldia anatina	Bay of Bengal	472–514	10·6	brown mud	b
(=*Malletia*) *angulata*	Bay of Bengal	521–741	—	green mud, pteropod ooze	b
Nuculana fumosa	Bay of Bengal	265–457	—	brown mud	b
indica (=*fumosa*)	Bay of Bengal	265–457	—	brown mud	b
Arca incerta	Laccadive area, Ceylon area	733–786	(3·3)	grey and green mud	b
pteroessa (=*asperula*)	Ceylon area, Bay of Bengal	2743–3007	1·7–1·9	green mud, globigerina ooze	a

Species	Area	Depth range m	Temperature range °C	Bottom sediment	abyssal a bathyal b
Limopsis indica (=*pelagica* pars)	Arabian Sea, Laccadive area, Ceylon area, Andaman area	260–2195	2·8–5·5	green and brown mud, globigerina ooze	(a)
Modiolus watsoni (=*A.politum*)	Gulf of Oman, Arabian Sea, Ceylon area, Bay of Bengal, Andaman area	315–1240	5·6–15·5	brown and green mud, sand	b
Amussium alcocki (=*watsoni*)	Arabian Sea, Laccadive area, Bay of Bengal	1026–1410	6·7–7·2	grey and green mud, globigerina ooze	b
andamanicum	Arabian Sea, Bay of Bengal	1258–1703	4·3	brown mud, grey ooze	b
caducum	Gulf of Oman, Arabian Sea, Laccadive area, S.W. of Ceylon, Bay of Bengal, Andaman area	691–1483	6·7–12·4	brown and green mud, sand, globigerina ooze	b
investigatoris	Laccadive area	410–519	11·1–12·2	sand	b
jeffreysi	Arabian Sea	1022	8·3	green mud	b
manaricum	S.W. of Ceylon, Andaman area	691–733	—	green mud, globigerina ooze	b
solitarium	Bay of Bengal	3297	1·7	globigerina ooze	a
Pecten alcocki	Laccadive area	786	(3·3)	grey mud	b
Lima indica	Laccadive area	658–786	(3·3)–9·2	grey and green mud	b
subtilis	Laccadive area	1957	3·1	green mud	(a)
Crassatellistes omanensis	Gulf of Oman	421	—	green mud, sand	b
Vesicomya brevis	Laccadive area	540–658	—	green mud	b
indica	Laccadive area, Andaman area,	658–741	8·9–9·2	green mud	b
cretacea	W. of Ceylon, Bay of Bengal	767–1985	2·7–12·4	green mud, globigerina ooze	b
Cryptodon acuticarinatus	N.E. of Ceylon	1114	6·7	brown mud	b
investigatoris (=*bisecta*)	Ceylon area	260–1114	6·7	brown and green mud, globigerina ooze	b
omanensis	Gulf of Oman	421	—	green mud, sand	b
philippinarum	Ceylon area	366–640	9·9–11·7	green mud	b
Lucina bengalensis	Laccadive area, Ceylon area, Bay of Bengal	658–1114	6·7–9·2	green and brown mud, sand	b
spinifera	Ceylon area	366–640	9·9–11·7	green mud	b
Cardium simillimum	Ceylon area	260–732	—	brown mud	b
Meretrix pudicissima	Gulf of Oman, Arabian Sea	218–421	—	green mud, sand	b
Dosinia salebrosa	Laccadive area	743	8·9	green mud	b
Venus juvenilis	Bay of Bengal	265–451	—	brown mud	b
Abra affinis	Bay of Bengal, Andaman area	412–1086	8·2	green mud	b
convexior	Ceylon area	366–640	9·9–11·7	green mud	b
maximum (= *profundorum* pars)	Arabian Sea, Ceylon area, Bay of Bengal, Andaman area	412–2376	2·2–12·7	green, grey and brown mud	a
Scrobicularia ceylonica	Ceylon area	1234	—	green mud	b
Tellina parvula (=*coromandelica*)	Laccadive area, Ceylon area, Bay of Bengal	243–1957	3·1–12·7	brown and green mud	b
travancorica	Laccadive area	496–658	9·2	green mud	b
Lyonsia jucunda	Andaman area	238–457	—	—	b
Myodora quadrata	Laccadive area	338–658	9·2–11·9	green mud, sand	b
Lyonsiella papyracea	Laccadive area	1840	1·9	green mud	(a)
Euciroa eburnea	Laccadive area, Andaman area	344–786	(3·3) 9·2–13·3	green mud	b
Poromya tornata	Bay of Bengal	3652	1·7	globigerina ooze	a
Myonera bicarinata	Laccadive area	1165	6·3	green mud	b
Cuspidaria alcocki	Bay of Bengal	1092	—	—	b
approximata	Andaman area	691–741	8·3	green mud, globigerina ooze	b
caduca	Andaman area	344–402	13·3	green mud	b
macrorhynchus	Laccadive area	1165	6·3	green mud	b

From the table, which enumerates 54 species, 47 would seem to be bathyal, while eight with some hesitation should be considered as abyssal. The following four species are widely distributed abyssal species, known from all three Oceans: *Arca pteroessa* (*Acar asperula*), *Limopsis pelagica*, *Abra maxima* (=*Abra profundorum* pars) and *Poromya tornata*. The remaining four species considered as abyssal: *Malletia brevis*, *Amussium solitarium*, *Lima subtilis* and *Lyonsiella papyracea* are too poorly known to be assigned with certainty to either the bathyal or abyssal fauna.

It should be mentioned also that the record of *Lucina spinifera* (Montagu) from "*Investigator*" St. 172 is possibly erroneous. The species is otherwise E. Atlantic ranging from the Norwegian Sea, W. Europe, the Mediterranean, off W. Africa to about 2°S. Nicklès (1955).

Ray (1952) recorded five deep-sea bivalves from the Indian Ocean, but unfortunately other data is lacking. The collection (which may originate from the "*Investigator*" expeditions) comprised the following species: *Nucula prestoni* Ray, 1952, *Lyonsia annandalei* Ray, 1952, *Cetoconcha indica* Ray, 1952, *Cetoconcha eximia* (Prashad, 1932), *Cuspidaria macrorhynchus* E. A. Smith, 1895.

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PLATES

PLATE 1

FIG. 1. *Nucula bengalensis* E. A. Smith. "*Galathea*" St. 489. Interior of right valve. × 2.
FIG. 2. *Nucula donaciformis* E. A. Smith. "*Galathea*" St. 453. Interior of right valve. × 2.
FIG. 3. *Acila divaricata* (Hinds). "*Investigator*" St. III. Interior of right valve. × 1·5.
FIG. 4. *Malletia angulata* Sowerby. "*Investigator*" St. 1. External view of left valve. × 2.
FIG. 5. *Malletia angulata* Sowerby. "*Investigator*" St. 1. Internal view of right valve. × 2.
FIG. 6. *Tindaria murrayi* n. sp. "*John Murray*" St. 26. External view of right valve. × 3.
FIG. 7. *Tindaria murrayi* n. sp. "*John Murray*" St. 26. Internal view of left valve. × 3.
FIG. 8. *Nuculana fumosa* E. A. Smith. "*John Murray*" St. 176. External view of left valve. × 3.
FIG. 9. *Nuculana fumosa* E. A. Smith. "*John Murray*" St. 176. Internal view of right valve. × 3.
FIG. 10. *Limopsis sansibarica* Thiele & Jaeckel. "*John Murray*" St. 184. External view of right valve. × 1·5.
FIG. 11. *Limopsis sansibarica* Thiele & Jaeckel. "*John Murray*" St. 184. Internal view of left valve. × 1·5.
FIG. 12. *Limopsis pelagica* E. A. Smith. "*John Murray*" St. 120. External view of right valve. × 2.
FIG. 13. *Limopsis pelagica* E. A. Smith. "*John Murray*" St. 120. Internal view of left valve. × 2.
FIG. 14. *Limopsis pelagica* E. A. Smith. "*John Murray*" St. 185. External view of left valve. × 1.
FIG. 15. *Limopsis pelagica* E. A. Smith. "*John Murray*" St. 185. Internal view of right valve. × 1.
FIG. 16. *Amussium meridionale* E. A. Smith. "*John Murray*" St. 185. External view of left valve. × 3.
FIG. 17. *Amussium caducum* E. A. Smith. "*John Murray*" St. 33. External view of left valve. × 2.
FIG. 18. *Amussium watsoni* E. A. Smith. "*John Murray*" St. 124. External view of left valve. × 1.
FIG. 19. *Amussium jeffreysi* E. A. Smith. "*John Murray*" St. 143. External view of right valve. × 2.
FIG. 20. *Amussium steindachneri* Sturany. "*John Murray*" St. 207. Internal view of left valve.
FIG. 21. *Amussium steindachneri* Sturany. "*John Murray*" St. 207. External view of right valve. × 3.
FIG. 22. *Amussium andamanicum* E. A. Smith. "*John Murray*" St. 119. External view of left valve. × 2.
FIG. 23. *Propeamussium sibogai* Dautzenberg & Bavay. *Th. Mortensen* St. 51. External view of left valve. × 1.
FIG. 24. *Propeamussium sibogai* Dautzenberg & Bavay. *Th. Mortensen* St. 51. Internal view of left valve. × 1.

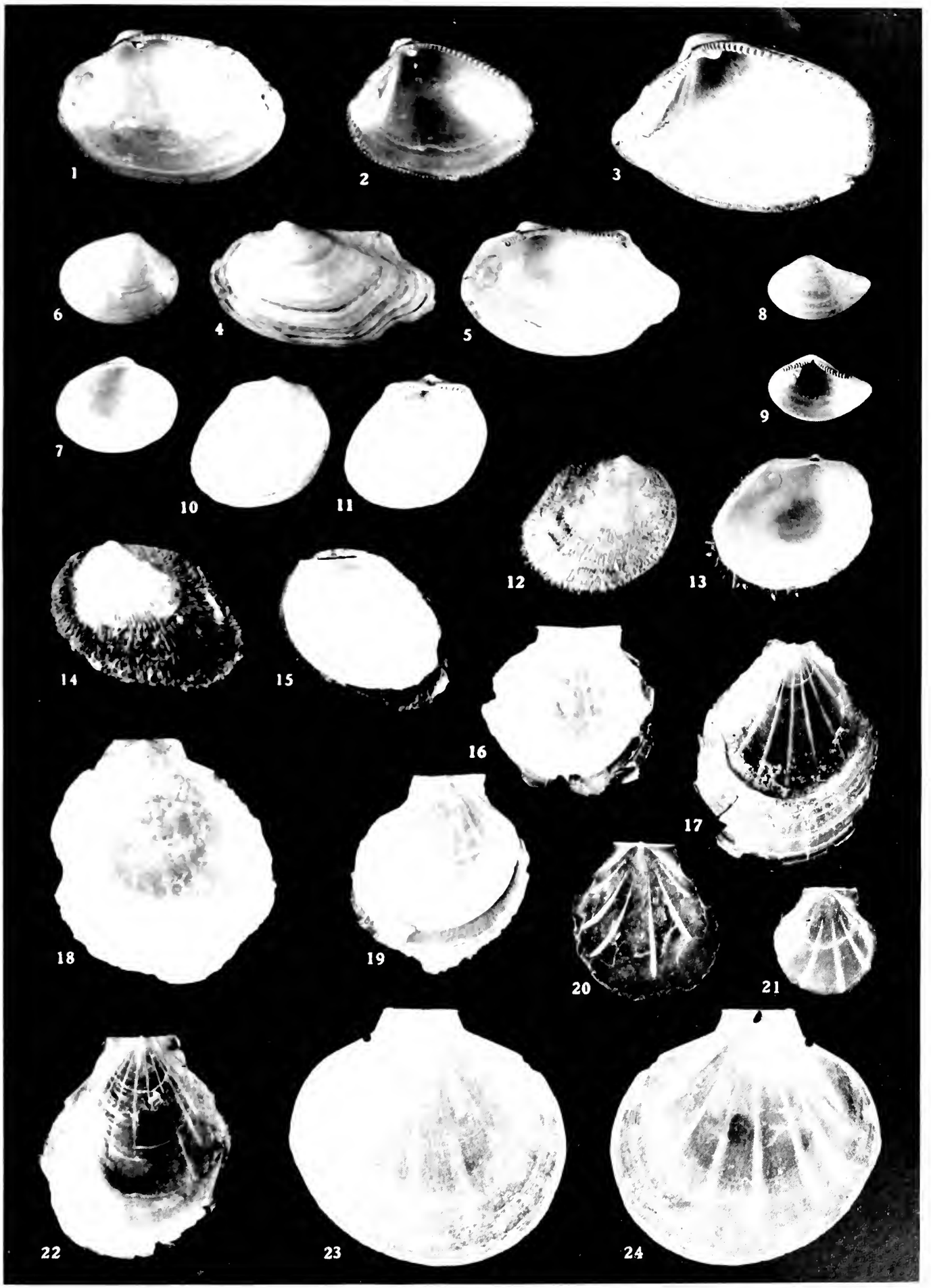

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PLATE 2

FIG. 1. *Amussium sewelli* n. sp., type. "*John Murray*" St. 118. External view of right valve. × 1·5.
FIG. 2. *Amussium sewelli* n. sp., type. "*John Murray*" St. 118. External view of left valve. × 1·5.
FIG. 3. *Pecten alcocki* E. A. Smith. "*John Murray*" St. 176. External view of right valve. × 3.
FIG. 4. *Pecten alcocki* E. A. Smith. "*John Murray*" St. 176. External view of left valve. × 3.
FIG. 5. *Pitar sewelli* n. sp., type. "*John Murray*" St. 66. External view of right valve. × 3
FIG. 6. *Pitar sewelli* n. sp., type. "*John Murray*" St. 66. Internal view of left valve. × 3.
FIG. 7. *Cryptodon bisecta* (Conrad). "*John Murray*" St. 59. External view of right valve. × 1·5.
FIG. 8. *Cryptodon bisecta* (Conrad). "*John Murray*" St. 59. Internal view of left valve. × 1·5.
FIG. 9. *Lucina inanis* Prashad. "*John Murray*" St. 125. Internal view of left valve. × 3.
FIG. 10. *Lucina bengalensis* E. A. Smith. "*John Murray*" St. 42. External view of right valve. × 3.
FIG. 11. *Lucina inanis* Prashad. "*John Murray*" St. 125. External view of right valve. × 3.
FIG. 12. *Venus juvenilis* E. A. Smith. "*John Murray*" St. 180. External view of right valve. × 3.
FIG. 13. *Venus juvenilis* E. A. Smith. "*John Murray*" St. 180. Dorsal view. × 3.
FIG. 14. *Venus juvenilis* E. A. Smith. "*John Murray*" St. 180. Internal view of left valve. × 3.
FIG. 15. *Tellina travancorica* E. A. Smith. "*John Murray*" St. 180. External view of right valve. × 1·5.
FIG. 16. *Tellina travancorica* E. A. Smith. "*John Murray*" St. 180. Internal view of right valve. × 1·5.
FIG. 17. *Tellina coromandelica* Salisbury. "*John Murray*" St. 77. External view of right valve. × 1·5.
FIG. 18. *Tellina coromandelica* Salisbury. "*John Murray*" St. 77. Internal view of left valve. × 1·5.
FIG. 19. *Myodora quadrata* E. A. Smith. "*John Murray*" St. 176. External view of right valve. × 3.
FIG. 20. *Myodora quadrata* E. A. Smith. "*John Murray*" St. 176. External view of left valve. × 3.

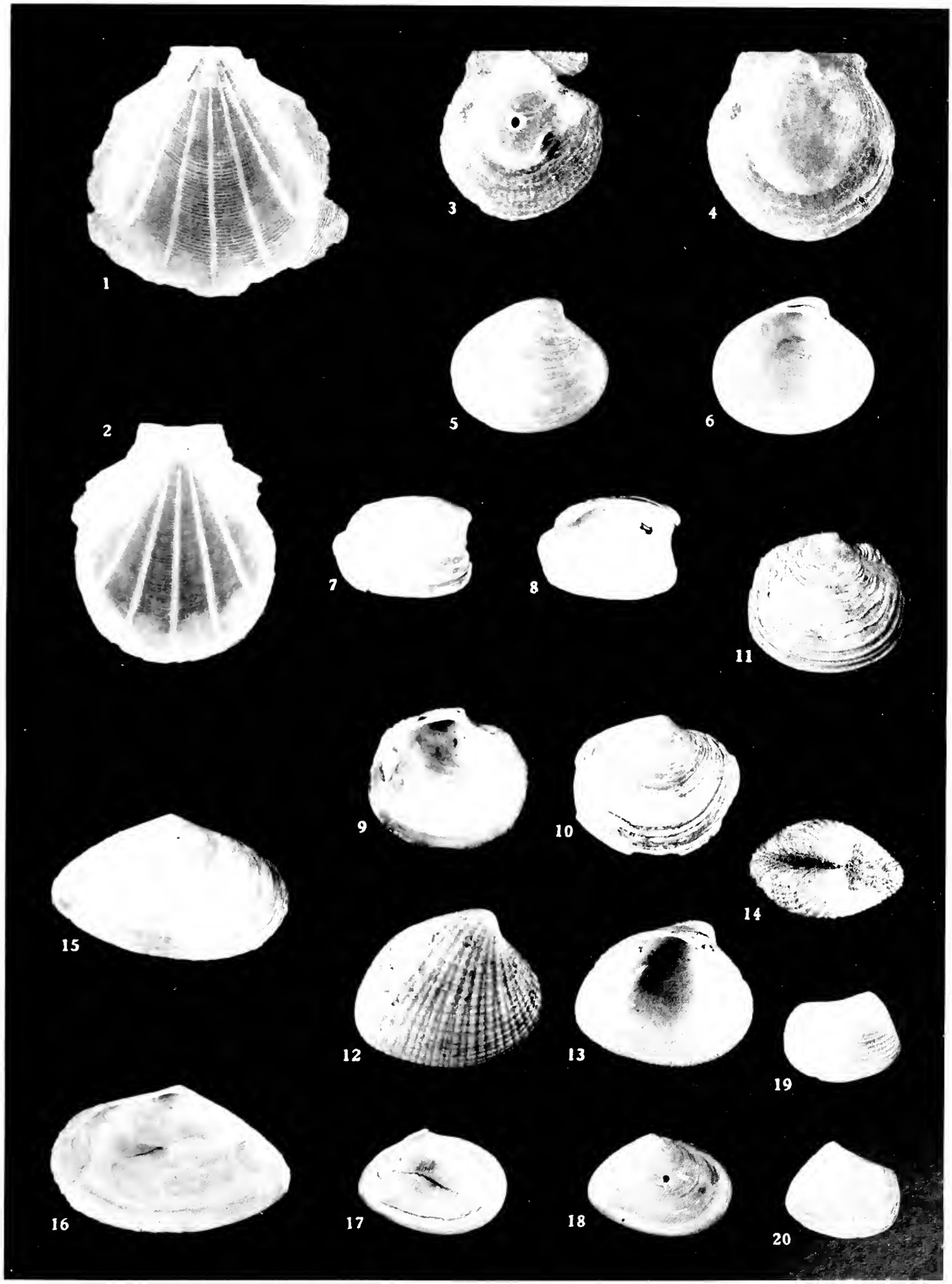
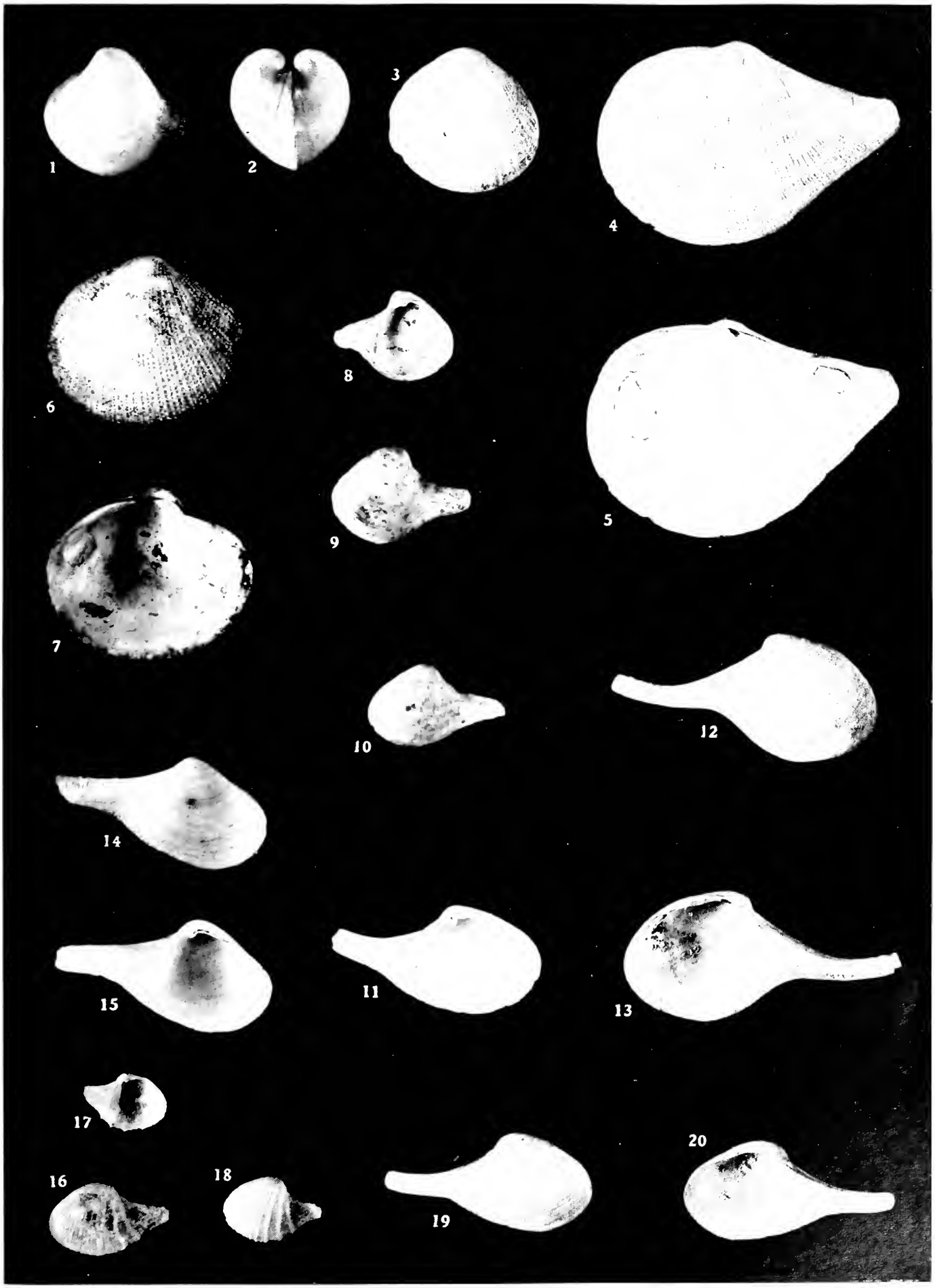

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PLATE 3

FIG. 1. *Poromya eximia* Pelseneer. "*John Murray*" St. 108. External view of left valve. × 2.
FIG. 2. *Poromya eximia* Pelseneer. "*John Murray*" St. 108. Frontal view. × 2.
FIG. 3. *Euciroa crassa* Thiele & Jaeckel. "*John Murray*" St. 159. External view of right valve. × 1.
FIG. 4. *Euciroa rostrata* Thiele & Jaeckel. *Th. Mortensen* St. 52. External view of left valve. × 1·5.
FIG. 5. *Euciroa rostrata* Thiele & Jaeckel. *Th. Mortensen* St. 52. Internal view of right valve. × 1·5.
FIG. 6. *Euciroa eburnea* (Wood-Mason & Alcock). "*John Murray*" St. 119. External view of right valve. × 1.
FIG. 7. *Euciroa eburnea* (Wood-Mason & Alcock). "*John Murray*" St. 119. Internal view of left valve. × 1.
FIG. 8. *Cuspidaria approximata* E. A. Smith. "*John Murray*" St. 108. External view of left valve. × 1·5.
FIG. 9. *Cuspidaria approximata* E. A. Smith. "*John Murray*" St. 108. Internal view of left valve. × 1·5.
FIG. 10. *Cuspidaria brachyrhynchus* Sturany. *Melvill* (1907, Gulf of Oman). External view of left valve. × 3.
FIG. 11. *Cuspidaria caducum* E. A. Smith. "*Galathea*" St. 202. Internal view of left valve. × 1·5.
FIG. 12. *Cuspidaria kawamurai* Kuroda. "*John Murray*" St. 145. External view of right valve. × 1.
FIG. 13. *Cuspidaria kawamurai* Kuroda. "*John Murray*" St. 145. Internal view of right valve. × 1.
FIG. 14. *Cuspidaria macrorhynchus* Thiele & Jaeckel. "*John Murray*" St. 107. External view of right valve. × 3.
FIG. 15. *Cuspidaria macrorhynchus* Thiele & Jaeckel. "*John Murray*" St. 107. Internal view of left valve. × 3.
FIG. 16. *Cuspidaria alcocki* E. A. Smith. *Melvill* (1907, Gulf of Oman). External view of left valve. × 3.
FIG. 17. *Cuspidaria alcocki* E. A. Smith. *Melvill* (1907, Gulf of Oman). External view of left valve. × 1·5.
FIG. 18. *Cuspidaria alcocki* E. A. Smith. *Melvill* (1907, Gulf of Oman). Internal view of left valve. × 3.
FIG. 19. *Cuspidaria steindachueri* Sturany. "*John Murray*" St. 6. External view of right valve. × 1·5.
FIG. 20. *Cuspidaria steindachneri* Sturany. "*John Murray*" St. 6. Internal view of right valve. × 1·5.


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